INDUSTRIAL ENGINEERING

COVERING THE PLANT ENGINEERING FUNCTION IN INDUSTRY

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L. C. MORROW, Editor

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Your Responsibilities in Handling Materials

. . . Big industrial plants are thoroughly convinced that they must do their handling of materials by means of machinery. If they don't so handle materials they are dropping back in the industrial race.

. . . Plants of medium size are installing more and more materials handling equipment.

. . . Small plants have not yet seen the light as well as they are destined to, but they are making headway.

. . . On whom rests the responsibility for seeing that machinery, instead of men, handles materials? The president? Yes. Works manager? Yes. Superintendent? Yes. Plant engineer? Yes. It would be in order to run the whole gamut, assigning this responsibility to each of its units.

. . . Granting the responsibility of management to decide that materials handling equipment is to be installed, it does not necessarily follow that management must discover the need for the equipment or decide what kind and what make are most suitable.

. . . In equipping a plant with materials handling machinery there are properly to be considered problems of selection, layout, installation, power application, and maintenance. These problems, divided functionally, must be solved by a number of individuals. It is not exaggeration, therefore, to say that the responsibility for seeing that materials are handled by machinery is divided among practically all of the management and engineering forces.

. . . Concerning this responsibility let the men in charge of the plant engineering function take heed. Theirs is a position from which can emanate the practical information vital to the selection of equipment that will render economical and efficient service. These men know the whys and wherefores in their own plants. They know the possibilities and the impossibilities. In no case should they fail to possess themselves of the knowledge of materials handling equipment and the details of operation that management has a right to demand from them when materials handling problems are up for discussion. Nor should they fail to take the initiative when they are convinced that the acquisition of such equipment will lower the cost of production in their plants.

Constant-Speed Drives for Long Conveyor Chains

Single, corner-sprocket drive from a 3-hp. motor for a conveyor 2,000 ft. long, traveling at 10 ft. per min.

By ROBERT W. DRAKE

Consulting Engineer
McCormick Works, International Harvester Company
Chicago, Ill.

Anyone who has tried to lay out a drive for conveyor chains that must be driven at more than one point will realize the difficulty of satisfactorily solving the many problems that are presented. In this article, which is the first of a series of two, the author describes the details of a method of driving constant-speed conveyor chains from any desired number of points which is radically different from those that have heretofore been employed.

WHEN the idea of conveying material by overhead chain conveyor was new, most conveyors were comparatively short. They could be driven from one point. Within the last few years very long conveyors have become quite common. Conveyors of this type more than 5,000 ft. in length, and carrying relatively heavy material, are in service. Surprisingly long conveyors may be driven from one point if they are supported by ball-bearing roller hangers and contain few turns.

Unfortunately many turns, both horizontal and vertical, are necessary in some applications. Many conveyors carry the supported material through two or more ovens in each of which the material must stay for considerable periods for drying. If the quantity of material to be handled is large, so that the conveyor must be operated at speeds of several feet per minute, whereas the time spent in each oven must be one hour or so, an oven with a chain straight through it becomes very long indeed. Space and other considerations generally preclude such a design.

Most often the choice is a rectangular oven, generally with internal partitions, with the chain zig-zagged back and forth inside. This design leads to a large number of right-angled turns in each oven. Frequently a considerable number of right-angled turns are also necessary outside the oven.

With modern chain, vertical turns are practical and a number of these may be required to pass the chain from floor to floor, to cross the empty return chain, and so on. The resistance of turns so greatly exceeds the resistance of straight chain that in most installations having many turns we can neglect the resistance of the straight chain and consider only that of the turns. The pull required to move the chain is not proportional to the number of turns. If we double the number of turns, we will require more than twice, but less than four times, the pull to move the chain; that is the pull increases between the first power and the square of the number of turns.

If this seems unreasonable, consider that each right-angle turn is to some extent a snub on the one ahead of it, and the one behind it, in turn a snub on it.

Drop-forged conveyor chain is very strong. With any drive in reason we are not likely to break the chain, but we do pull down corners. Thus so far as the chain is concerned, we might operate with 5 tons pull in a heavy chain. However, the side roller guides at the corners would fail or wear out rapidly, and we would find it difficult to design

and brace corner supports to resist a pull of 5 tons each way, a total reaction of 14,000 pounds.

Obviously, the answer is to use two or more drives on each chain, but this involves certain difficulties. Several highly ingenious methods, as well as some simple ones, have been devised for overcoming these difficulties. Some of the simple methods will be described but we will not consider those methods, no matter how excellent, which permit only two drives to a chain. There are many chains on which more than two drives are necessary and there is frequently a chain that a chain may be extended, thus requiring more driving points. Why put up a drive with which this is impossible?

Fundamental Difficulties in Designing Multiple Drives

The principal difficulty arises from the fact that if one drive tends to run a little faster than the other it will build up a tension ahead of the other drive and, due to snubbing action, corners begin to break or pull loose from the ceiling, or the chain breaks.

The most obvious solution would seem to be a single motor driving a chain at two places through a lineshaft and two speed reducers driven by silent or roller chain, as in the diagram on page 393. This arrangement is often possible, for the return chain frequently passes near the outgoing chain at several points. There are installations where this method of driving has been a success. On other installations it has been a failure; in these latter cases, strange as it may seem, the slack all disappears behind one drive in the course of a few hours, an excessive tension builds up, and if the slack is not readjusted by hand something breaks, usually a corner. The cause is obscure, and very likely is different on different jobs. The following causes may lead to such difficulties:

1. When a chain is extended, the pitch of the new chain will be a trifle shorter than the old chain, due to wear of the old pins and links. When all the new chain is in one-half of the drive, there might easily be 0.010 in. per link difference. With each section containing 2,000 links or more, there can be differences in slack of 20 in. or more, which is three or four times what an ordinary drive layout can take care of. Possibly, careful steel-tape measurements of the chain under tension in service, and the distribution of the short-pitch chain in several sections throughout the entire chain drive should cure this condition.

2. Sooner or later some of the product will catch somewhere, a chain will climb a sprocket or something "jam" the chain. The tension that builds up before something breaks may be sufficient to stretch the chain in one-half of the drive. The forged links do not really stretch; the pins bend a trifle.

3. On a chain where there are many right-angle bends, the "give" in the corners may introduce slack. This may appear equally in all sections of the chain, but more likely not. If the slack becomes great enough to be troublesome a link or two may be removed. Then if the chain is ever loaded with a lighter product, the section where the links have been removed will tighten up.

4. If the split sprockets on the lineshaft that drives the two speed reducers are not keyed to the shaft, one may slip when a section of the conveyor chain jams or drives hard, due to a rub somewhere, and rob slack from the other sections of the drive. I have never known this to happen, but valuable time is wasted checking up to see if it did happen before anyone gets on the track of the real trouble.

On the whole, then, mechanical coupling of the sections of a drive is expensive at best, and difficult or impossible if the return drive does not come close to the outgoing drive at some point that will give two fairly equally loaded sections.

When variations of speed in the conveyor of, say, 5 per cent are not serious there is a better way of driving which has these advantages:

1. Drives may be located on the chain wherever convenient although it is best to have roughly equal loads on the various motors driving the sections.

2. It is easy to limit the pull on each section below that which will break corners.

3. The drive is not affected by differences in chain pitch, whether from wear, bent pins, stretch, or inaccuracies in manufacture.

Briefly, this method involves driving the various sections with several identical slipring induction motors. The rated horsepower of each motor should be about two or three times the actual horsepower load on the

This 4,800-ft. conveyor is driven through two caterpillar drives by a 5-hp. motor. The conveyor travels at a speed of 20 ft. per minute and goes through two ovens kept at 350 deg. F. and three ovens kept at 180 deg. F. The conveyor makes 50 horizontal and two vertical turns.

Caterpillar drive on a 1,500-ft. conveyor for handling lacquered parts. The driving motor is rated at 3 hp. This conveyor chain travels at 10 ft. per minute and makes 20 horizontal turns, with two vertical bends on the return line.

motor; thus, if the drive will require ½ to ¾ hp. per section, use a 1½- or 2-hp. motor.

Install these motors with sufficient slipring (secondary) resistance to give a drop in speed below synchronous speed of 20 to 25 per cent, not at full load, but with the actual load which the motors will carry. As one can ordinarily estimate only very roughly what that load will be, it will be advisable to install adjustable resistors, or resistors with taps, each having two or three times the resistance which it is estimated will be needed, as you will almost always overestimate the actual horsepower required by such a drive.

On the other hand it is well to select resistors having current-carrying capacity sufficient for the full-load secondary current on the motor, at least on the last few steps to be cut out. This means that a resistor for fan duty, not machine tool duty is needed.

Of course, in figuring the speed reduction for the drive it is necessary to take the motor speed at 80 per cent of the nameplate speed, or 75 per cent of synchronous speed.

With so much secondary resistance in circuit, variations in the load on any motor will affect its speed appreciably. That is, if the chain tightens up behind one motor, its speed will drop a little and tend to equalize with the other motor. A heavy tension can not be built up behind one motor, for it will slow down and let the others do the work.

The speed of such a conveyor will vary 5 or 10 per cent between no load and full load on the chain. Do not adjust the speed until there is full load on the chain; it will run fast when lightly loaded. If various products are handled on the chain, some light, some heavy, the chain will run a trifle faster on the lighter loads. If the chain runs through a paint oven this increase in speed is usually permissible, for the lighter material heats up more quickly in the oven and will dry thoroughly in less time.

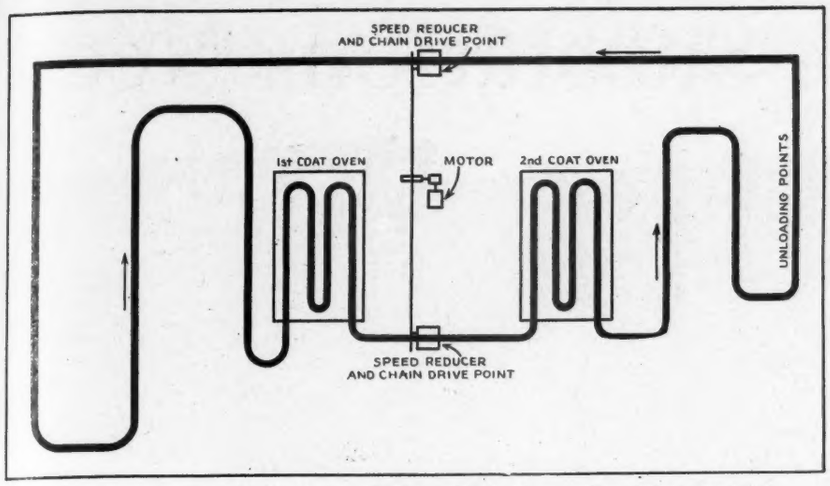
If the secondary resistors for the drive motors are adjustable, the chain speed can be varied a little with them. However, do not vary it over more than 6 per cent from the limits stated above. If the drive is speeded up too much, the automatic load division will be so reduced that heavy stresses may be produced in one section of chain. If the motor is slowed down too much, it will stall on any abnormal increase in load. The maximum torque that the motor can produce has been greatly reduced by putting so much resistance in the secondary, and trouble is likely to ensue if an attempt is made to run much below 75 per cent of synchronous speed, or 80 per cent of full-load speed.

In case it is necessary to change the conveyor speed considerably it is best to do so by changing the motor sprocket driving to the reducers. If it is desired to raise the speed 10 per cent, put on a sprocket with 20 per cent more teeth. When the chain is operated at the higher speed, the motor will be more heavily loaded. It will, therefore, slow down so that the speed increase will not be nearly in proportion to the increased number of teeth in the drive sprocket as is the case with a constant-speed motor. Similarly, if it is necessary to slow down the drive 10 per cent, install a sprocket with 20 per cent less teeth.

Should it be possible to divide the conveyor into several sections, each containing an equal number of similar turns, horizontal and vertical, and somewhere near equal lengths of straight chain, the load on each section will be nearly equal. This condition is often possible on a paint chain if one drive is near the center of the empty chain return, and one drive is between the first- and second-coat ovens. If, however, one section contains a straight run, whereas another has little chain and more turns, and a third has a long inclined rise of 20 or 30 ft. vertically, it is difficult to predetermine the loads so that the sections will take reasonably equal horsepower.

In this connection I can only say that a few turns will take more power than much straight-away, and that, angle of turn being equal, vertical turns are much worse than horizontal turns, if ball- or roller-bearing roller supports are used on the horizontal turns.

If an inaccurate estimate is made the slack will appear in the rear end of the heaviest-loaded section. Due to snubbing action, the loads on all the other motors will be increased until they equal, roughly, the load on the heaviest section, but the load on the heaviest section will not be appreciably reduced thereby This is not strictly true, but it is very nearly true if there are a number of turns



Typical layout of double drive chain mechanically synchronized by means of jackshaft driving two speed reducers.

or offsets in every section. If some sections are all straight chain, particularly the section pulling away from, or ahead of, the heaviest-loaded section, this statement will be less closely true.

Note that the load will be about the same on all motors, due to snubbing, even if the actual pull required to move the sections is widely different. Then, under ordinary operating conditions, you cannot tell whether you have estimated the section loads correctly, by any electrical tests that can be made on the motors; they will all test about the same anyway.

What Can Be Done About It?

If the motors are loaded below 1/3 to ½ rating there is no great harm in leaving conditions this way. The wear on corner roller bearings will be considerably increased in all sections except the one which has the slack in its rear end. Up to a certain point we can improve matters by cutting out resistance in the secondary or slipring circuits of the motors pulling the sections with the slack in them, and increasing the resistance in the sections where there is considerable tension in the chain at the end of the section opposite to the drive end.

If adjustable secondary resistors have been used this alteration is not difficult, and a little cut-and-try experimenting will no doubt improve matters greatly. The object is to obtain some slack in the rear end of each section. If there are more than three sections all we can hope for is to obtain an adjustment where there is no considerable tension in the chain at the rear end of any section, as judged by swaying the chain sideways with the hand.

It was stated above that with identical motors and with equal secondary resistances, electrical tests with wattmeters or otherwise, will tell almost nothing about whether the sections are correctly chosen to give equal loads. Due to snubbing, all the motors will carry loads approximately as great as the true load on the heaviest-loaded section. This is closely true only if there are a number of turns in each section. How then can we determine whether the loads in the sections are approximately balanced; that is, whether we have made a good estimate and located the various drives correctly? There are several methods of doing this.

In each case have normal loading and temperature conditions on the chain throughout its length. If the test is to be made some night or on a Sunday, do not neglect to unload the chain as it passes the normal unloading points. It is surprising what a difference it will make to run a few loads by, on to the normally empty return sections. Now, adjust the secondary resistances to make them equal on each phase of each motor. This will take time, of course, and require considerable testing, unless the resistances were tested and marked at every "point" of the faceplate before they were installed.

Run the chain for a short time to be sure that bearings are not stuck with paint which has dried on since the drive was last run. Then connect the wattmeter in one motor circuit. If this motor can be run with the chain at the rear of the section ahead dead slack, you know that the next motor ahead is not helping it to pull its section. If the chain is dead slack in the far end of its section you know that it is not trying to help the succeeding motor in line.

The ordinary procedure is to take off the motor drive chains to the speed reducers and turn these by hand until you have the slack where you want it. Then put on the chains, get a man set at the wattmeter and start all motors in the regular way.

If the chain comes up to speed and the wattmeter steadies down, so that the reading can be obtained before the slack disappears either ahead of the motor under test or at the far end of the section it is pulling, you are in luck, and have the desired data. If a reading can not be obtained use more slack and repeat.

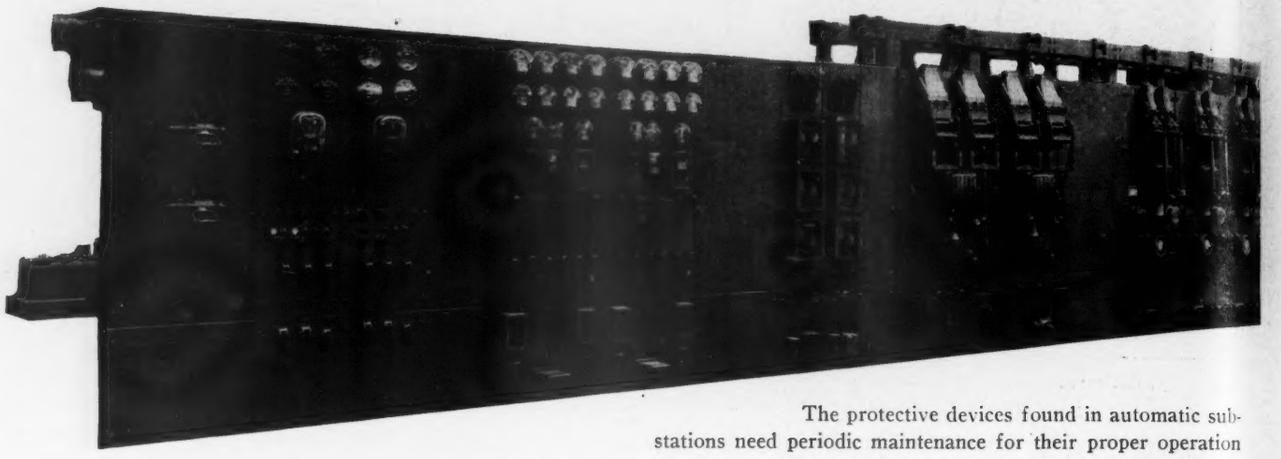
If the loads on the sections are very unequal, it may be necessary to take out a pin in the chain in the far end of the section under test, and just ahead of the drive under test. This is, of course, impossible with installations where the conveyor chain is driven by a sprocket, but is practical with a "caterpillar" drive.

Each section of the chain may be tested separately by either method.

In a succeeding article, to appear in an early issue, details will be given of the control for such drives with the layout of variable-speed chain drives.

THERE can be no doubt as to the value of efficient service departments to the General Manager, if they relieve him of the pressure of routine. The heads of these departments must be leaders and thinkers, rather than drivers. These departments must not only be efficient personally, but they must cultivate among their workers a high order of efficiency. They must be of inquiring and scientific mind, and analytical of temperament, men who can see the need of change think accurately, and formulate plans to be submitted to the General Manager, for the effective installation of equipment and methods, required by that change. This, of course, is the ideal arrangement, wherein the chief executive has merely to study the merits of such proposals, and either improve on them or reject them, but it is indeed very fortunate that a wide range of administrative duties are now being delegated to engineers, as men of *scientific training.*—C. S. Proudfoot, *President, A. I. S. E. E., Gen'l Mgr. Vanadium Corporation of America, before Association of Iron and Steel Electrical Engineers.*

Automatic Substations Need



The protective devices found in automatic substations need periodic maintenance for their proper operation

IN NO other field is the following adage more true than in the operation of automatic stations: "An ounce of prevention is worth a pound of cure." The ratio is perhaps altogether too small measured by the benefits obtained from adequate, systematic and intelligent inspection. The word intelligent really covers the field for, in a broad sense, the word includes the terms adequate and systematic.

Much of the development work carried on by the manufacturers has been with the idea of reducing the necessity of maintenance and inspection to a minimum. The devices and schemes of operation which have been produced from this development render the automatic station a unit in any system, which not only contributes to the economic operation, but one which also does much to promote continuity of the service supplied by that system.

Practical analysis verifies the statement that nothing is perfect. Any commercial device is a compromise between perfection and cost. The quality of service to be expected is thus necessarily a measure of the maintenance required to offset those things by which a device or an equipment as a whole falls short of perfection.

If the outage of a unit is not a serious matter and time may be allowed for clearing up, for example, a failure in switching sequence which should normally render the unit inoperative under certain conditions, there will always be a tendency to neglect the matter of routine inspection and maintenance. The failure of protective devices, which might result in costly damage as well as extended outage is, however, a far more serious thing. For this reason, the automatic station is safeguarded by a multiplicity of protective devices not ordinarily found in attended stations. In protecting against equipment failures, one protective device is often backed-up by another so that only by simultaneous failure of separate and independent protective devices could serious damage be done to the equipment. These protective devices are the products of years of research, development and experience; but only by intelligent use, such as proper calibration and adequate maintenance may they be expected to render the service for which they are intended.

Use a hardwood toothpick to clean the commutator undercutting of motor-operated relays. Leave it inside the cover where it will be available for the next cleaning.

* * * *

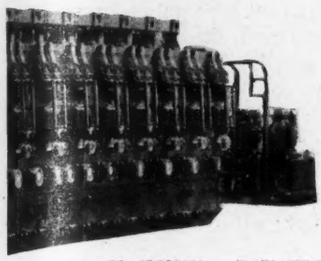
The importance of continuity of service renders the proper functioning of the switching sequence of equal importance with that of protective equipment. Intimate knowledge of the proper functioning of each device and its relation to other devices is the first qualification for one responsible for the inspection or maintenance of automatic stations. Such an individual need not be a technically trained man, but he should have in addition to a fair grasp of the fundamentals involved, experience not only in the operation of the equipment itself, but a knowledge of the relation of the station to the rest of the system. The latter is important if he is to be able to properly analyze the limitations of the equipment and make adjustments accordingly.

The usual practice is to have two men working together as a maintenance crew consisting of the maintainer and his helper. This arrangement has several advantages. Safety First demands it. The work can be done more quickly. Men are constantly being trained to carry on the work in the event of change in personnel.

It is difficult to outline an exact maintenance schedule which will fit the needs of all users, since conditions vary for each individual installation. It is the duty of the man in responsible charge of equipment to outline the maintenance schedule. This can best be done after he has become thoroughly familiar with the problem. The manufacturer has inspection forms which can be supplied and which will serve as a guide to the maintainer. These forms contain a complete list of the equipment with suggestions as to the parts of the individual device which will need in-

Systematic Maintenance

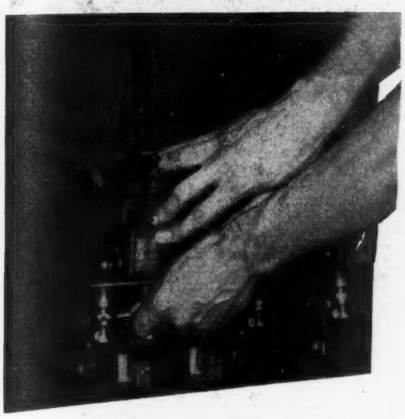
for dependable operation



By G. F. JONES

Switchboard Engineer
Westinghouse Electric & Manufacturing Company
E. Pittsburgh, Pa.

spection. Each item is followed by a blank space in which the maintainer may make suitable comments which should include conditions found and work done. It will be found that if a permanent record is made of these reports, they can be used to make a study which will help



An interlock must open or close its contacts well within the limits of travel of its operating device. Such adjustments are made externally.

* * * *

toward securing maximum continuity of station service. The typical form, however, should only be used until the engineer can make up an individual form which he finds will better suit his needs as he becomes more familiar with the problem.

The manufacturer supplies instruction books for individual pieces of apparatus and also a general instruction book which gives a complete analysis of the scheme of operation. The latter is made up for the individual installation. An inspector or maintainer should be thoroughly familiar with these books.

Cleanliness is an indication of proper maintenance. Foreign matter such as dirt, rust or moisture will be found to contribute to a large percentage of equipment failures. Lubricants should be used with judgment.

In general, from a maintenance standpoint the work can be divided into two classes. In the first will be included routine maintenance which will consist of inspection of the switching equipment and machine at frequent intervals which for the average installation will be once a week.

During this period voltage regulator contacts are examined, and the condition and amount of fluid in the dash pots are determined. Inspection is made of the contacts of all glass-covered relays. This inspection is to be done with the aid of a flashlight without removing the glass cover, and if it found necessary to clean the contacts it can be done with carbon tetrachloride. If the contacts are burned, a fine abrasive such as crocus cloth may be used freely, but before replacing the cover the relay should be blown out with a hand-operated bellows. Never use an air line for this purpose.

Normally, the only maintenance that a control contactor will need will be the removal of any coating from the inside of the arc chute. The contacts should be allowed to wear to a natural shape. Sand paper may be used to clean the contact surfaces. The use of a file is to be avoided, for unless very carefully done, filing will give poorer contact than natural wear and the life of the contacts will be materially shortened.

Interlocks operated by control contactors and power switching devices are very important. They must be examined for condition of contacts and for adjustment The main actuating device should be operated slowly by hand and the interlock observed to see that it makes or breaks its contacts well within the limits of the travel of its operating device.

AUTOMATIC SUBSTATION INSPECTION REPORT

Date.....19.....
Transformers
Rotating Equipment
Switching Equipment

.....Automatic Substation Inspector.....

Inspection started.....A. M. P. M. Inspection finished.....A. M. P. M

"Be sure high-tension disconnects are open before starting inspection." Instructions to inspectors: To check mechanical operation, actuate device by hand, noticing that there is no binding and that the device is lubricated properly. The contacts should be clean and unpitted. If otherwise, they should be dressed until this condition is satisfactory. Be sure that contacts which should make simultaneously, do so. Be sure that all nuts on all binding posts are tight. Check electrical operation while starting up.

No. 1	Master Element (d.c. under-voltage relay)
	Fuse unblown? .....
	Contacts?.....Mechanical operation?.....
No. 2	Time Delay Starting Relay
	Contacts?.....Mechanical operation?.....
	Time is?..... Sec.....
No. 3	Master Relay
	Series resistors? .....
	Contacts?.....Mechanical operation?.....
No. 4	Master Contactor
	Contacts?.....Mechanical operation?.....
No. 35	Brush Lifting Device
	No. 35X contactor?.....
	Oil in gear case?..... Grease on exposed gears?.....
	Do brushes lift clear of commutator?.....
	Do brushes seat fully?.....
	Contacts?.....Do they make and break correctly?.....
No. 52	Oil Circuit Breaker and Mechanism
	Foundation bolts solid and tight?.....
	Abnormal friction?.....Excess play in parts?.....

Fulcrum pins tight and oiled?.....Lock nuts tight?.....
Main contacts clean?.....Make good contact?.....
Do auxiliary switches make and break correctly?.....
Oil clean?.....Level correct?.....
52M Operating motor?.....
52Z Low-voltage mechanism.....

No. 6X Starting Contactor Control Relay
Contacts?.....Mechanical operation?.....

No. 6 Starting Contactor
Main contacts are?.....
Interlock contacts are?.....
Mechanical operation?.....
Interlock does not bind?.....
Lubrication of interlock?.....

No. 7 Polarized Motor Relay
Contacts "A".....Contacts "B".....Contacts "D".....
Mechanical operation (spin motor and rotate drum)?.....
Lubrication (gears and bearings)?.....

No. 9 Field Reversing Relay
Contacts?.....Mechanical operation?.....

No. 41 Field Contactor
Upper Contacts?.....Lower contacts?.....
Mechanical operation?.....

No. 7X Polarized Motor Auxiliary Relay
Contacts?.....Mechanical operation?.....

No. 42X Running Contactor Control Relay
Contacts?.....Mechanical operation?.....

No. 42 Running Contactor
Main contacts are?.....
Interlock contacts are?.....
Mechanical operation?.....
Interlock does not bind?.....
Lubrication of interlock?.....

No. 40 A.C. Machine Field Relay
Contacts?.....Mechanical operation?.....

No. 71 D.C. Emergency Circuit Breaker
Contacts?.....Mechanical operation?.....

No. 72 D.C. Contactor
Contacts?.....Mechanical operation?.....

No. 76 D.C. Overcurrent Relays
77 Contacts?.....Mechanical operation?.....

No. 73 Lead-Limiting Resistor Shunting Contactors
75 Contacts?.....Mechanical operation?.....

No. 37 Undercurrent Relay
Contacts?.....Mechanical operation?.....
Drop-out value? (approx.).....

No. 62 Time Delay Stopping Relay
Contacts "S".....Contacts "T".....
Mechanical operation (spin motor and rotate drum)?.....
Lubrication (gears and bearings)?.....
Sec. to operate "S"......"T".....

No. 12 Overspeed Limit Device.
Contacts?.....Mechanical operation?.....
Does device shut station down?.....

No. 28 Resistor Thermal Relay
Contacts?.....Mechanical operation?.....
Do contacts reset properly?.....
Does relay shut station down?.....

No. 30 Annunciator Lockout Relay
Contacts?.....Targets?.....Mechanical operation?.....

No. 32 D.C. Reverse Current Relay
Contacts?.....Mechanical operation?.....
Does relay shut station down?.....Setting.....

No. 38 Bearing Thermal Relays
Contacts?.....Mechanical operation?.....
Do relays lockout the station?.....

No. 46 Reverse-Phase or Phase-Balance Current Relay
Contacts?.....Mechanical operation?.....
Does relay shut station down while in normal running position?.....
Does relay lockout the station if it operates while the machine is starting?.....

No. 47 Single or Reverse-Phase Voltage Relay
Contacts?.....Mechanical operation?.....
Will phase failure operate relay (remove pot, trans. fuse)?.....
.....
Does relay shut station down?.....

No. 49 A.C. Thermal Relay
Contacts?.....Mechanical operation?.....
Does relay shut station down?.....

No. 51 A.C. Overcurrent Relays
Contacts?.....Mechanical operation?.....
Do relays lockout the station?.....

No. 64 Flashover Relay
Contacts?.....Target?.....Mechanical operation?.....
Does relay lockout the station?.....

Synchronous Converter
Pilot brushes?.....Main d.c. brushes?.....
Commutator?..... Commutation? .....
A.C. brushes?.....Slip rings.....
Bearings?.....Is machine clean?.....
Connections tight? .....
Field current.....amp. at.....per cent load
Field discharge resistor current.....amp.
Insulation resistance (armature).....megohms
Insulation resistance (field).....megohms
Power factor at full load.....

Power Transformers
Oil clean?.....Level correct?.....
Connections tight? .....

Operating Transformers
Oil clean?.....Level correct?.....
Connections tight?.....Fuses unblown?.....

Potential Transformers
Connections tight?.....Fuses unblown?.....

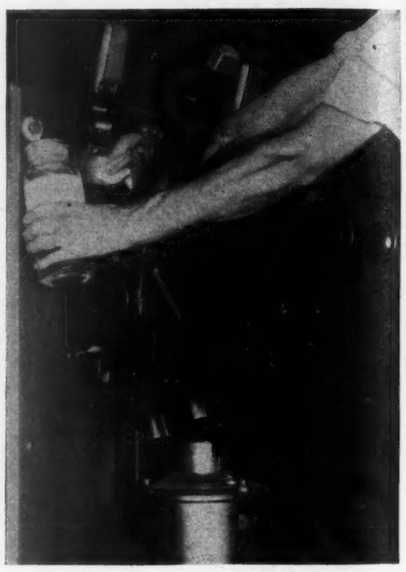
Current Transformers
Connections tight? .....

Remarks:—.....

Supt., Test and Repairs

Operation counters are supplied with some power switching devices. A record of their readings made at regular intervals will give a very good indication of system conditions and will aid in locating defects.

Direct-current circuit breakers must be cleaned thoroughly at the main and auxiliary contact surfaces. Such parts can be cleaned satisfactorily with carbon tetrachloride or crocus cloth. All links and pins should be examined for wear. Bearing surfaces should be given a few drops of light oil at regular periods.



Clean contacts in proper adjustment will not overheat. Carbon tetrachloride is the cleansing agent used.

* * * *

Too much oil, however, must not be added, as it will get into places where it does not belong.

Each feeder should be opened preferably by operating the tripping relays, particularly when it is of the automatic short-circuit detector type, by means of voltage from a dry cell applied at the terminals of the impulse coil. In reclosing it should be controlled by the automatic reclosing relays. It is recommended that due to the fact that a feeder does not operate except at the time of a d.c. fault, this operation be done every time the station is inspected.

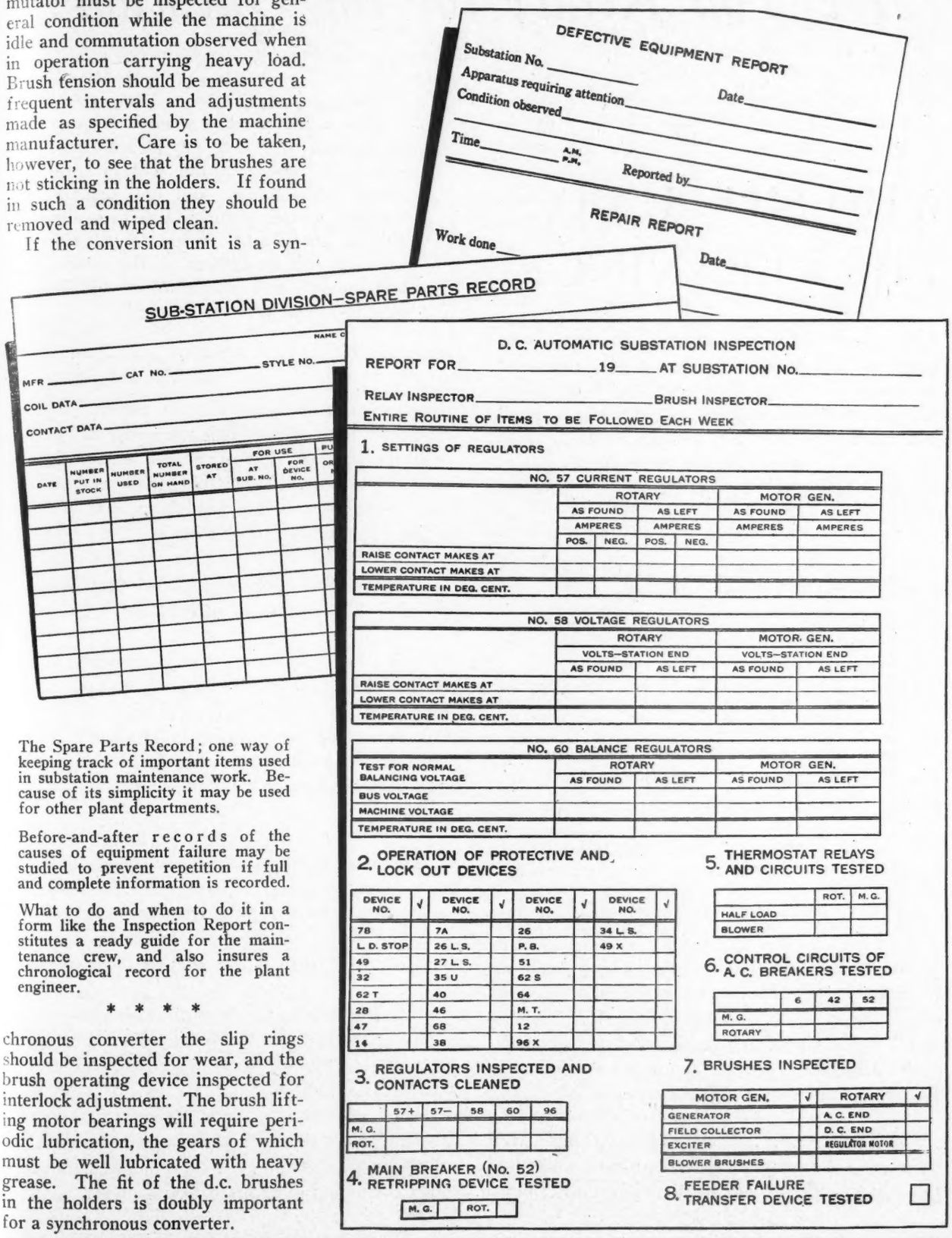
The switchboard, front and rear, and all auxiliary apparatus such as rheostats, grid resistors and the exterior portions of oil circuit breakers should be blown out with compressed air at a pressure never exceeding 75 lb. per sq. in. And when cleaning the rear of the switchboard, all metering and control wiring should be examined for loose connections.

Machines should be blown out at least once a week. Inspection covers should be removed from the pedestals while the machine is running to see that the oil rings are revolving and carrying sufficient oil. The commutator must be inspected for general condition while the machine is idle and commutation observed when in operation carrying heavy load. Brush tension should be measured at frequent intervals and adjustments made as specified by the machine manufacturer. Care is to be taken, however, to see that the brushes are not sticking in the holders. If found in such a condition they should be removed and wiped clean.

If the conversion unit is a synchronous converter the slip rings should be inspected for wear, and the brush operating device inspected for interlock adjustment. The brush lifting motor bearings will require periodic lubrication, the gears of which must be well lubricated with heavy grease. The fit of the d.c. brushes in the holders is doubly important for a synchronous converter.

If the station control energy is taken from a storage battery it will require inspection for general condition. It will be found that the best satisfaction is secured if a glass jar battery is selected at the time of purchase. Hydrometer and temperature readings should be recorded. This latter record will, of course be suitable for both room and electrolyte temperatures.

(Please turn to page 424)



DEFECTIVE EQUIPMENT REPORT

Substation No. _____

Apparatus requiring attention _____ Date _____

Condition observed _____

Time _____ A.M. P.M. Reported by _____

REPAIR REPORT

Work done _____ Date _____

SUB-STATION DIVISION—SPARE PARTS RECORD

NAME C

MFR _____ CAT NO. _____ STYLE NO. _____

COIL DATA _____

CONTACT DATA _____

DATE	NUMBER PUT IN STOCK	NUMBER USED	TOTAL NUMBER ON HAND	STORED AT	FOR USE AT SUB. NO.	FOR USE FOR DEVICE NO.	PU OR

D. C. AUTOMATIC SUBSTATION INSPECTION

REPORT FOR _____ 19____ AT SUBSTATION No. _____

RELAY INSPECTOR _____ BRUSH INSPECTOR _____

ENTIRE ROUTINE OF ITEMS TO BE FOLLOWED EACH WEEK

1. SETTINGS OF REGULATORS

NO. 57 CURRENT REGULATORS

	ROTARY				MOTOR GEN.	
	AS FOUND AMPERES		AS LEFT AMPERES		AS FOUND AMPERES	AS LEFT AMPERES
	POS.	NEG.	POS.	NEG.		
RAISE CONTACT MAKES AT						
LOWER CONTACT MAKES AT						
TEMPERATURE IN DEG. CENT.						

NO. 58 VOLTAGE REGULATORS

	ROTARY VOLTS—STATION END		MOTOR GEN. VOLTS—STATION END	
	AS FOUND	AS LEFT	AS FOUND	AS LEFT
RAISE CONTACT MAKES AT				
LOWER CONTACT MAKES AT				
TEMPERATURE IN DEG. CENT.				

NO. 60 BALANCE REGULATORS

TEST FOR NORMAL BALANCING VOLTAGE	ROTARY		MOTOR GEN.	
	AS FOUND	AS LEFT	AS FOUND	AS LEFT
BUS VOLTAGE				
MACHINE VOLTAGE				
TEMPERATURE IN DEG. CENT.				

2. OPERATION OF PROTECTIVE AND LOCK OUT DEVICES

DEVICE NO.	√	DEVICE NO.	√	DEVICE NO.	√	DEVICE NO.	√
78		7A		26		34 L. S.	
L. D. STOP		26 L. S.		P. B.		49 X	
49		27 L. S.		51			
32		35 U		62 S			
62 T		40		64			
28		46		M. T.			
47		68		12			
14		38		96 X			

3. REGULATORS INSPECTED AND CONTACTS CLEANED

	57+	57−	58	60	96
M. G.					
ROT.					

4. MAIN BREAKER (No. 52) RETRIPPING DEVICE TESTED

M. G.		ROT.	

5. THERMOSTAT RELAYS AND CIRCUITS TESTED

	ROT.	M. G.
HALF LOAD		
BLOWER		

6. CONTROL CIRCUITS OF A. C. BREAKERS TESTED

	6	42	52
M. G.			
ROTARY			

7. BRUSHES INSPECTED

MOTOR GEN.	√	ROTARY	√
GENERATOR		A. C. END	
FIELD COLLECTOR		D. C. END	
EXCITER		REGULATOR MOTOR	
BLOWER BRUSHES			

8. FEEDER FAILURE TRANSFER DEVICE TESTED ☐

The Spare Parts Record; one way of keeping track of important items used in substation maintenance work. Because of its simplicity it may be used for other plant departments.

Before-and-after records of the causes of equipment failure may be studied to prevent repetition if full and complete information is recorded.

What to do and when to do it in a form like the Inspection Report constitutes a ready guide for the maintenance crew, and also insures a chronological record for the plant engineer.

* * * *

Are You Ready for the Question?

Here is the third of a series of questions, each of which has at least two sides. A new question will be presented next month, and our readers' answers to this month's question also will be published. Write down your opinions and send them to the editor. Incidentally, answers published will be paid for at an attractive rate.

WHO SHALL DO THE CLEANING?

Back in May Frank Fulleger, a plant engineer, and George Shipman, a works manager, discussed the question, "What Shall Be the Maintenance Policy?" In the June special "Severe Service" issue they did not appear. In July, however, they wrangled a bit about "Should the Plant Engineering Department Have the Right to Question Orders?"

In this issue Shipman is visiting Fulleger's plant, and has run across Frank just after Frank has closed a meeting of the committee for coordination of plant engineering activities. The two men are seated in Frank's office.

* * * *

"Good meeting today, Frank?" asked Shipman, by way of finding out whether or not Frank wanted to talk about the subject up for discussion.

"Yes, George," said Frank. "We talked cleaning today."

"Any conclusions?"

"Well, I found that the example I cited to emphasize the necessity for a clean plant was something of a boomerang. Told Jim Billings that I was disappointed at the condition of Hodson's department after Sunday's overhauling. Jim came back something like this:

" 'If your order had called for cleanup, Mr. Fulleger, I'd have kept on enough men to do the job. But I didn't want to employ such high-priced men on cleaning without authority. You object to dirt for production employees, but you overlook the fact that my skilled men will have to do the cleaning if everything is to be shipshape after a Sunday's work. I think we're big enough to have a special cleaning crew.' "

"What did he mean by a special cleaning crew, Frank? Thought you had one."

"I do, George, but they are a scattered bunch. Each department has from one to three handy men who do the cleaning and other odd jobs. Of course, the two cleaners in Hodson's department were on the job first thing Monday morning, but they couldn't do the work in less than half a day."

Shipman saw the problem. "It gets down to this, then," he said, "that you have to decide whether you'll let the departments do their own cleaning, or put all the cleaners under a boss and let him send them where they're most needed."

"Looks that way, George," Fulleger replied. "If I do, though, some departments are going to be without anybody to do miscellaneous cleaning, run errands, and so on."

"But don't the operators depend too much on these people now? Isn't there a lot of unnecessary cleaning and errand-running done?"

"I suspect so, George. It may be that our cleaning will cost us less if I centralize it. Perhaps that case I cited wasn't such a boomerang after all."

"Personally, I think you're on the right track, Frank. But don't overlook anything. Remember that there are certain cleaning jobs that have to be done at certain times; that at other times all routine cleaning has to be dropped for emergency work; that odd hours and overtime are required if all production departments are to be clean all the time. And above all, remember that a cleaning boss has to be a good man—he must be able to understand what is wanted, and why, and at the same time direct a gang that's none too far up the line when it comes to thinking things out. He has to be a man with patience and a great deal of foresight."

"You're right, George. Not all of the problem has been solved when I say that I'll have or not have a special cleaning crew. I'll keep the matter on the scrambled egg that I use as a mind and let you know what I do. And now, come on. I know you're anxious to see that new bunch of speed reducers and the new lubricating equipment I was telling you about."

Saying which, Fulleger led Shipman out of the office into the plant.

* * * *

On rather careful examination it doesn't seem that Frank and George have given all the pros and cons on this subject of cleaning. Perhaps they deliberately acted that way, hoping to have the other points brought out by INDUSTRIAL ENGINEERING *readers. If so, they are playing right into the editor's hands. You now have your chance to sweeten the pot. Mail your discussion so that it reaches the editor by the first of September. And here are some leading questions:*

Should plant cleaning be done by each department or by a general plant cleaning crew?

In the absence of a regular cleaning gang should the maintenance groups be expected to clean up after an overhauling, or should the department in which the work is done clean up?

If either skilled or production workers have to do clean-up work, how does it affect their feelings toward their jobs?

Is Frank heading in the right direction, or should he find some other solution to his problem?

Readers' answers to previous questions

Shall the Plant Engineering Department Have the Right to Question Orders?

(Question Presented in July Issue)

"HE who hesitates is lost," as the proverb goes, is perhaps more true in the progressive industry of today than in any other phase of modern structure. Almost every change for the good involves that "bugbear" of moving in one sense or other. The watchword then must be to guard against abuse of this seemingly necessary evil.

In a majority of cases major consideration must be given to the engineering and maintenance problem that a move might effect—thus avoiding undue delays and shutdowns in the future when equipment is again in operation. The department responsible for keeping the plant in operation should therefore have a right to question any moving order where a question is in order. This step will also often bring to light figures as to not only present but future costs which would otherwise not be discernable on the surface.

Let me cite one or two instances:

It was recently decided to move a machine from one department to another. The location was spotted and an estimate of the cost given. The job was approved by all concerned until it reached the engineering department. Investigation there proved that a foundation would have to go to bed-rock some 15 or 20 ft. below the surface, since this unit must be absolutely free from vibration. This meant that the cost of the move would be at least five times more than estimated. A re-check made clear that the unit was not in operation enough to justify the expense.

Another striking example was that of a motor placed in such a position so as to conserve a little floor space. This was done on the original installation. However, when the motor (which was a built-in affair) burned out it required at least a day and a half

for replacement, due to inability to get at it without completely dismantling the equipment. Needless to say that one or two costly shut-downs preceded moving this prime mover.

In still another instance it was required to alter and relocate several tables and benches along with building a few additional ones. Investigation disclosed that in another department, remote from the one in which the moving was to be done, were unused tables, etc., that almost exactly met the requirements of the first department—thus saving many dollars. True, there is no engineering problem here, but there is one of alteration which, when needlessly done, eats into profits.

The foregoing are just a few examples to illustrate that orders involving moving should be carefully checked by the plant engineer or maintenance department. Additional items to be checked against when making a move are: Possibility of increased rate of depreciation; increased overhead; safety hazards; effect upon insurance rate.

Incidentally, I have always personally felt that the responsibility of moving—that is the labor involved—should come under the master mechanic or superintendent of maintenance as the case may be, although many large, progressive plants have this department under separate supervision. Where the first mentioned policy is carried out there should be a minimum of overhead and supervision costs; also undue delays and improper sequence are more easily curtailed.

Every move should have for its ultimatum the good of the whole establishment wherein it is made and not the particular department. This holds true whether a small machine, miscellaneous equipment, layout of a department or even a whole building is involved.

These results can hardly be obtained where a department head is the sole authority for a major moving problem involving his department. His constructive criticism, comments and approval should by all means be obtained for harmonious co-ordination, but final say-so should lie with an individual or organization entirely independent of any particular operating department. This authority might be given to an efficiency Department or, where quality or questions of process are involved, to a technical control head—and in major items final approval should rest with the general superintendent or works manager. The final details of procedure here, of course, depend upon the size and type of organization and product manufactured. Where the foregoing procedure is taken, due consideration is given to all sides.

H. L. SCHULTZ, *Asst. Supt. of Maintenance, Carborundum Company, Niagara Falls, N. Y.*

THE question of who should have the final say-so on moving equipment depends on circumstances, but it will generally be found that the General Manager has the final power of authorizing the moving if it is extensive; and rightly so, since he holds his position by the authority of the board of directors who are in turn responsible to the shareholders.

Some men in minor authority would be constantly experimenting and changing equipment to suit their own particular whims if allowed to do so, whether there was any direct benefit to be derived in such moving or not. In the main, however, all matters pertaining to the moving of equipment should be thoroughly discussed and passed upon before the authority is granted. There have been several instances in my own experience where it has been necessary only to mention the fact to the head of affairs, who has readily seen the benefits to be derived, and who has stopped all discussion by simply saying "go-ahead." Such procedure is time-saving.

Again, there have been instances where considerable discussion has arisen from an idea hatched overnight, and that has been shelved until authorized by dire necessity, or after a severe break-down. None of us are infallable, but it is only in rare instances where changes can be made without authority which, when discovered by the head of affairs, will satisfy him of their true merit.

Every minor executive or department head should have the right to question moving orders if the equipment of his particular department is to be affected. He is, or should be, thoroughly conversant with his maintenance costs and, as in practically every case moving is charged to maintenance rather than capital expenditure, his views should be placed before the other department heads before final authority is granted.

If one department head authorized changes in existing equipment without consulting with other department heads, although he had authority from the plant manager, the results might be disastrous to the plant as a whole, and might mean a lengthy shut-down—though admitedly this would be an extreme case.

As a concrete example, assume that a master mechanic wanted to change a drive which would necessitate the moving of a large motor to a new location to make room for an additional machine to be driven from the same motor. The electrical superintendent would certainly have the right to question the moving orders on several counts: (1) as to the location of the motor as regards proper operating conditions, (2) location of the control equipment for the same reasons, (3) the type and length of transmission medium between motor and load, and (4) the ability of the motor to provide for the added load. This is only one instance, and the same should be true in all cases even though the moving orders are issued by the plant manager himself.

Where changes are contemplated in existing equipment, there are several factors that require consideration. Among others, the most important are increased production, lower maintenance, and safety of operation. It is a well known fact that in most cases the scrapping of obsolete equipment is a step toward greater economy. One of the greatest aids in plant economy is the periodical survey of plant equipment. It is only by means of such a survey that the important facts of power, fuel, and oil wastage, high maintenance costs, production spoilage, and high accident rate can be discovered and remedied.

H. E. STAFFORD, *Electrical Engineer, Port Arthur, Ont.*

SHOULD the plant engineering department have the right to question orders? To a certain extent, yes.

The details of the actual move are undoubtedly the responsibility of the plant engineer. The final say as to whether the move is necessary should belong to the head of the department where the equipment is needed. He knows, or presumably knows, the reason for the change. He should consult the plant engineer as to layout, trucking, crane service, raw material, feeders.

Should no doubt be left that the move is absolutely necessary, it is in the hands of the plant engineer to handle the move, paying due heed to figuring ahead on all facilities such as power, crane, trucking, water.

The location cannot always be settled arbitrarily by the production department. A location that may, from the production standpoint, be perfect may entail expensive fixtures and removals and may not be in line with wiring, safety, and fire precautions.

The production department is not expected to know of the important details from an engineering standpoint of a considerable move such as lifting a boiler or an elevator. They are likely not to know of the conditions in the new location concerning underground lines, electrical feeders and losses through overlong steam lines.

I would suggest that when the plant engineer is given a "moving" order he prepare a scale drawing of the new location showing existing equipment. He should take this up with the production department and when both have gotten together on the move, the plant engineer should be given the sole authority on how the move is done. The job is his until he hands it over, ready to run, to the production department.

MAURICE C. COCKSHOTT, *Mechanical Engineer, Hancock Oil Co., Long Beach, Calif.*

What Shall Be the Maintenance Policy?

(Presented in the May Issue)

IT is hardly possible or economic for the average industrial plant to do all of its own maintenance work. However, with a majority of the plants the percentage of this work done within the plant may run very high.

The work contracted outside of the plant may be divided into two classes:

1. The kind of work requiring particular skill or trade, with tool and equipment requirements not in line with the general policy of the plant:

a. Brick work such as walls and arches of furnaces, smoke stacks, alterations in building construction.

b. Certain types of pipe work, plumbing, and insulating.

c. The moving and setting of peculiar or special types of machinery.

d. Certain building repair jobs beyond the average carpenter, such as replacing asphalt or other types of roofing or guttering or even certain kinds of cement work.

e. Certain types of welding or machine work.

2. Where limited time puts the job beyond the physical ability of the force available.

Work requiring special skill or equipment should be let to contract shops only when the amount is not sufficient to keep the skilled employees in reasonably constant employment or show investment on ownership of equipment. If the plant is organized to do the work along the same lines as the contract shop the cost will be less. Otherwise it probably will work in favor of the contract shop.

I think that most departmental heads should welcome a limit on the amount of an order. It is human to assume no more responsibility than necessary; beside, those above are being paid for that particular service.

There may be difference of opinion as to what constitutes necessary and unnecessary maintenance work. It seems to me that any work needing to be done is necessary work. Unnecessary work is not usually done to keep someone employed. There may be minor exceptions, but generally the men are shifted to necessary work not in their line, and even to production, which, when properly explained, very seldom causes friction.

It was not necessary for Frank to know why the new policy was adopted. That it was bona fide was sufficient for him to trim his sails accordingly, regardless of the weather in the offing.

—GEORGE S. BILLMAN, *Anderson, Ind.*

MAINTENANCE work should be handled by the chief engineer of the plant and should be kept at a very high standard.

The chief engineer should be advised of any new installations and it should be left entirely with him to arrange for the moving or installation of all machinery or piping of any nature.

The policy with a great many maintenance men is to let things run until breakdown; this is entirely the wrong view to take as more damage will result if the machine is in operation when a piece breaks.

If the maintenance work is contracted to job shops the tendencies will be to "leave this piece until next time."

I do not believe the general manager or superintendent of a plant should have the final say in questions of maintenance unless they are practical men, because a machine would be run too long in most cases, and the repairs would be considerably more.

Another reason for doing the work with the home crew: It would be more carefully done because they would have to do it over if it were slighted in any way.

In case of contracting the work out you have the disadvantage of loss of production for a longer period of time on account of the inability to get a man on the job as quickly as you could if the home crew were used.

In small and medium-size plants there is always sufficient work to keep a maintenance crew busy and handle emergency jobs, too, if the man in charge is of the proper type and making regular inspections. My trouble is getting sufficient competent help to handle the work.

—W. H. PENDERGRASS, SR., *Chief Engineer, Atlantic Paper Co., Atlanta, Ga.*

POWER TRANSMISSION

Through Friction Clutches

By WILLIAM STANIAR

Chairman of the Advisory Board
Power Transmission Association
Power Transmission Engineer
E. I. du Pont de Nemours & Company and Subsidiaries, Wilmington, Del.

DURING the past ten years the use of friction clutches has increased rapidly, owing, no doubt, to the many improvements in clutch design and the realization that operating, but non-producing, machinery represents a loss, not only in power, but in increased maintenance. Friction clutches are most adaptable to group lines driving batteries of machines or various types of apparatus, because in almost all cases there are periods when certain machines or apparatus should be idle, while others are operating and producing from the same source of power.

The problem of connecting full-speed power to dead load is always present in industrial operations. In many instances this is accomplished by shifting a belt from a loose to a tight pulley, and for the average light load this is practical. There are, however, many cases where starting loads are severe, whether light or heavy and cases where a chain connection (which cannot be shifted) is imperative. It is for such conditions as these that the friction clutch was designed.

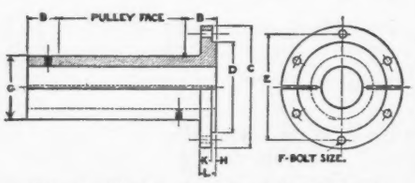


Fig. 1—Plain, cast-iron, bored and reamed friction clutch sleeve.

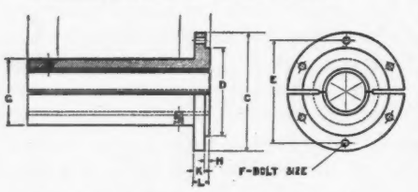


Fig. 2—Cast-iron, babbitted friction clutch sleeve.

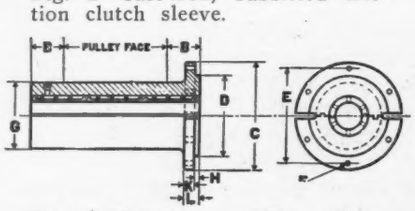


Fig. 3—Cast-iron capillary-oiling, bronze-bushed, friction clutch sleeve.

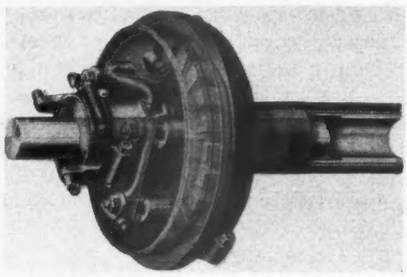


Fig. 4—The split-toggle and wood-friction-block friction clutch.

The friction clutch connects power at full speed to dead load by the frictional resistance between its engaging parts. This engaging of power and load is controlled by a suitable mechanism so that the acceleration of the load to the required speed is quick but without severe impact or shock.

There are numerous types and designs of friction clutches on the market, each possessing some individual mechanical characteristic as to the methods of engaging the friction resistance portions, the sleeves and the friction members; however, in the final analysis, although the mechanisms may differ, the result is the same.

The modern friction clutch consists generally of three principal parts: the sleeve and friction drum or ring, which operates loose on the shaft and to which is keyed the load-connecting medium such as pulley, gear, sprocket, or sheave; the clamp disc, or part that engages the friction ring or blocks of the sleeve drum, this part being keyed to the power input shaft; and the engaging mechanism, which is controlled by a sliding yoke and collar.

Friction-Clutch Sleeves—One of the most important parts is the sleeve, to which is keyed the driving member such as pulley, gear, sprocket, or sheave, because when the clutch is running idle the sleeve acts as a journal bearing The most common form of clutch sleeve is the plain, cast-iron bored and reamed type (Fig. 1) lubricated by grease through compression cups at each end. This type is neither babbitted nor bronze-bushed, but is entirely of cast iron, accurately bored and reamed to shaft size. For moderate loads, and where a clutch is not called upon to run idle for long periods, a sleeve of this character is suitable. Within a short time after it is put into service, the bore becomes glazed and with proper lubrication will run almost indefinitely without appreciable wear.

In actual operation, however, proper lubrication of this type of clutch sleeve depends to a great extent on the human element, because it is not self-lubricating. Compression grease cups are used which require frequent attention and, in many instances, clutches are operated in such locations that the necessary attention is not given them. Lack of lubrication in a sleeve of this type causes rapid wear on the sleeve itself and scoring of the shaft on which it is operating. This type of sleeve is usually made to accommodate shafting from $1\frac{5}{16}$ to $7\frac{1}{2}$ in. in diameter.

Another sleeve frequently employed is the babbitted type, (Fig. 2), which is particularly adapted for high speeds. The babbitt readily conforms to the slightest inaccuracies of the shaft. When the babbitt becomes worn, it is not necessary to discard the entire sleeve, because the babbitt can easily be renewed. In this type, however, the matter of lubrication is important because the

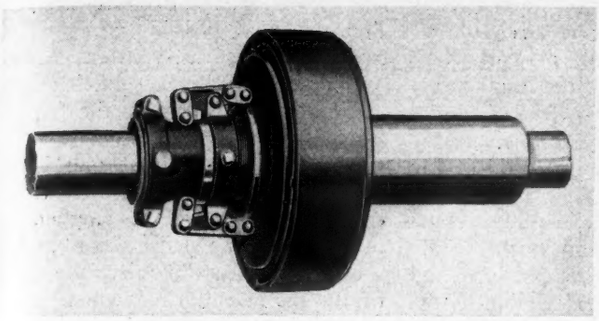


Fig. 5—Solid-toggle and wood-friction-block friction clutch.

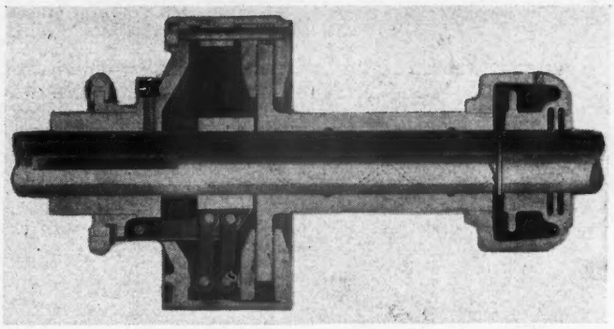


Fig. 6—Lined-disc and self-oiling-sleeve friction clutch.

application is made through the medium of grease cups and also depends on the human element. With proper lubrication, a babbitted clutch sleeve will run for long periods without trouble.

This type of sleeve is usually made to accommodate shafting $1\frac{3}{16}$ to $7\frac{1}{2}$ in. in diameter.

Another sleeve employed is known as the loose bronze-bushed type and is particularly adapted for heavy belt strains. The loose bronze bushing is split and is tongued and grooved at the joints. A series of radial holes are drilled through the walls of the bushing through which the grease lubricant passes. This bushing runs loose inside the sleeve and the cast-iron part of the sleeve runs loose upon the shaft.

In a clutch of the split type, the cast-iron part of the sleeve and the bronze bushing are both split; therefore, it is an easy matter to replace the bushings when wear occurs. Even with this type of sleeve, the matter of proper lubrication is again dependent on the human element, because compression grease cups are employed. This type is made to accommodate shafting $1\frac{5}{16}$ to 7 in. in diameter.

Manufacturers of certain types of clutches have produced what is known as the capillary-oiling, bronze-bushed, cast-iron sleeve (Fig. 3) which is not dependent upon the human element for proper lubrication. The capillary sleeve is made with an oil chamber between the cast-iron portion and the bronze bushing. The latter has a series of small holes drilled through it into which are fitted soft pine plugs. The lubricant chamber is filled with oil instead of grease and the oil gradually works its way through the soft pine plugs to the shaft. Oil is used exclusively in this type of sleeve.

This type of sleeve should be used

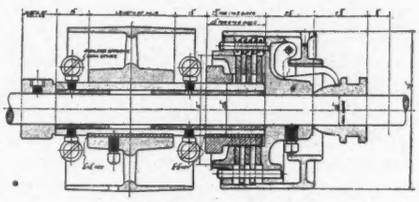


Fig. 7—A modern type of high-speed friction clutch.

where it is necessary for a clutch to be disconnected from its load for a considerable length of time, with the shaft still running. The capillary-oiling bronze bushing is tightly fitted to the iron part of the sleeve, thus preventing any leakage of oil. This feature makes it impossible to furnish a bushing alone; if replacement is required, it is necessary to purchase a complete sleeve.

This type is made to accommodate shafting from $1\frac{5}{16}$ to $6\frac{1}{2}$ in. in diameter.

Types of Friction Clutches Available

Toggle and Wood-Friction Block Clutch—A modern split clutch of this type is shown in Fig. 4. This clutch is made both solid and split—Fig. 5 showing the solid type—but split when the outside diameter is approximately 10 in. or over. The split clutch of this type is made from 10 to 72 in. in diameter and has a capacity ranging from 6 hp. at 100 r.p.m. to 1,000 hp. at 100 r.p.m. It should not be operated, unless specially balanced, at speeds higher than 450 r.p.m. for the 10-in. and 275 r.p.m. for the 72-in. size.

This clutch has great friction power which is obtained from an outside disc into which are driven hard maple blocks presenting end grain, an inside driving plate which is keyed to the shaft, and an outside driving plate attached to the inside driving plate and levers. By a movement of the levers or toggle mechanism, the driving plates are brought in contact with the wooden blocks. This style of clutch is suitable for almost any service desired, whether the load be light or heavy, or the speed high or low.

The Lined Disc and Self-Oiling Sleeve Type—An efficient and serviceable clutch of this type is shown in Fig. 6. Three pairs of one-arm toggles disposed at 120 deg. are arranged to roll radially outward on convex tool steel plates. This particular form of toggle gives low average and a large friction plate clearance at the point of disengagement increasing rapidly as engagement is obtained and reaching infinity when the rolls have reached the apexes of the roll plates. The sleeves of this type of clutch are made in both the grease-lubricated and the ring-oiling types. The former should be used for speeds up to 150 r.p.m., whereas the latter should be used for higher speeds. The grease-lubricated

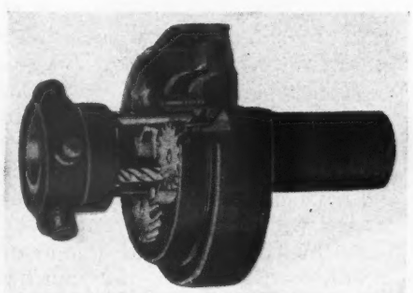


Fig. 8—Friction clutch using worm-and-gear control.

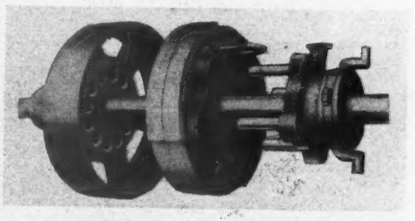


Fig. 9—This friction pick-up and positive-lock clutch is designed for handling light loads.

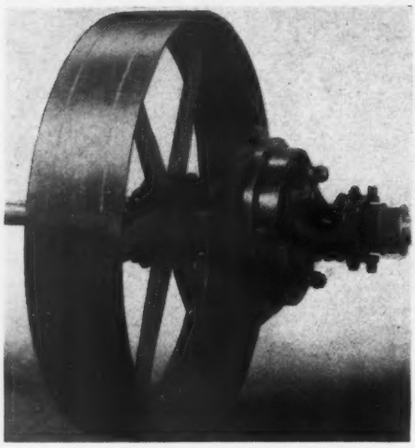


Fig. 10—A split clutch with split pulley keyed on the sleeve.

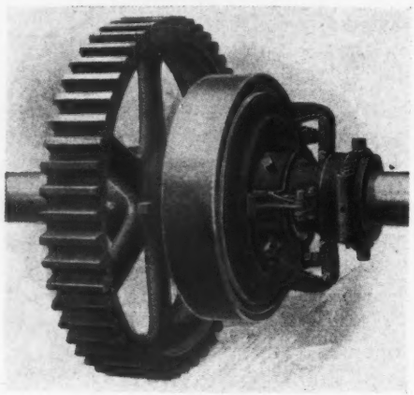


Fig. 11—Solid clutch with solid gear keyed to its sleeve.

sleeves are provided with grease cups and grease-circulating grooves. As shown in Fig. 6, the ring-oiling sleeve has a reservoir and revolving oil ring.

High-Speed Clutches—A modern type of high-speed friction clutch with cast-iron sleeve is shown in Fig. 7. This type is made in solid construction only, because at high speed the split type is not so safe. Clutches of this type are made of cast iron and beyond certain speeds are made of steel with two to six bronze discs. For small power and moderate speeds, two or three-disc clutches are recommended. For high speeds and high powers it is advisable to use a small clutch with many discs in order to keep down centrifugal force.

Worm-and-Gear-Controlled Clutch—This type, shown in Fig. 8, utilizes an entirely different mechanism for engaging purposes. The friction elements of this clutch are a series of hardwood or asbestos blocks. The engaging discs are of cast iron and are drawn against the friction blocks by means of worm-threaded studs operated by spiral gears rotated by racks to the sliding collar. Ball-thrust bearings are provided for the spiral gears to reduce the effort necessary to engage the clutch. In this type, just so long as there is any space between the hub or body of the clutch and the sliding collar, the clutch can always be thrown tighter and readjustment is not necessary until these two parts come together.

The sleeve of this clutch, in the standard sizes, is integral with the drum portion of the mechanism, but can be obtained in various styles: namely the plain-reamed bore, the floating, bronze-bushed type, the ball-bearing bore and the flexible-steel-roller bore. The plain-reamed sleeve should not be used above 250 r.p.m. Above 250 r.p.m. the floating, bronze-bushed sleeve should be employed until speeds such as 800, 1,000 or 1,500 r.p.m., which are possible with this type, are reached. For these speeds, the ball-bearing or flexible-steel-roller bearing sleeves should be employed and the clutch, as a whole, should be in perfect balance.

Friction Pick-Up and Positive Lock Clutch—There are many cases where the regular type of wood-block friction clutch is a hazard when operating in the presence of flammable vapors, due to the possible slipping of the friction elements resulting in heat and perhaps sparks. Many times a clutch is called upon to withstand alternating shock loads instead of a steady driving pull and, regardless of the engaging mechanism design, there is a possibility of slipping caused by these intermittent shocks.

For such cases, the clutch shown in Fig. 9, and known as the friction and positive-lock clutch has been designed. Both the light and heavy types pick up the load by the internal expansion of an asbestos ring against the inside of the sleeve drum, and as soon as the drum acquires the speed of the expansion ring, which is the speed of the driving shaft, pins attached to the expansion-ring disc are forced into holes in the sleeve drum, by further movement of the engaging yoke, and the expanding friction ring is automatically released.

For the higher powers, circular-engaging, internal and external, small-pitch gears are employed instead of the pin-and-hole construction, because equal distribution of the load is possible around the periphery of the gears, thus enabling the clutch to be more easily engaged and disengaged.

The Coil-Spring Clutch — This type of clutch is a radical departure from the average style used in industrial operations. It has been specially designed to meet requirements of service necessitated by the frequent stopping and restarting of heavy high-powered units that accelerate rapidly. There is practically no limit to its capacity; the largest unit at present in operation transmits 8,000 hp. at 50 r.p.m. The friction surfaces are chilled iron to steel and lubrication is provided when out of engagement.

This type of clutch consists of but four essential parts: a drum forming the driving member; the coil and plate to which it is fastened; the driven member, and a suitable means of control. The coil is made of high-carbon steel of great tensile strength. The small end, or tail, of the coil is freed when the clutch is out of engagement, the large end being permanently attached to a plate forming

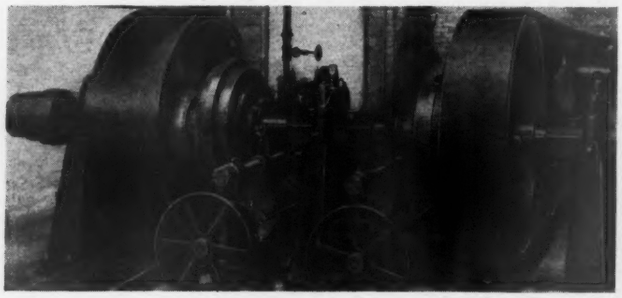


Fig. 12—A typical installation of solid friction clutches using gear and segmental rack control.

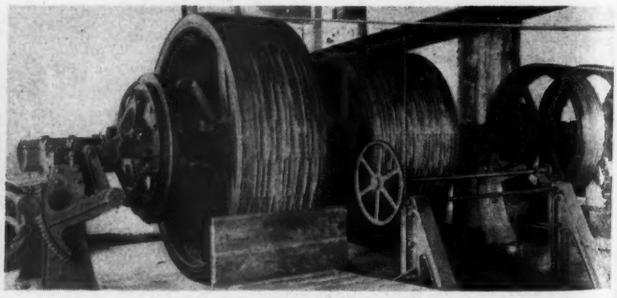


Fig. 13—Installation of mechanically-controlled, heavy friction clutches.

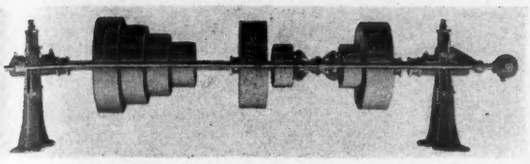


Fig. 14—Arrangement of friction clutches in duplex on machine tool countershaft, for reversing direction of rotation.

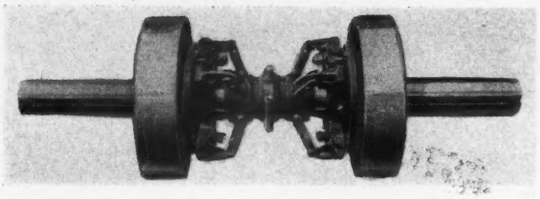


Fig. 15—Friction clutches arranged in duplex on lineshaft.

the driven member. To engage the clutch, the tail is advanced by a lever, causing it to come in contact with the drum, which then gradually tightens the coil about it to a point where both become practically an integral unit resulting in a highly efficient drive.

As the friction surfaces of the clutch come into contact progressively an easy picking up of the heaviest load is possible. For this reason, this type is particularly adapted for haulage, rolling mill, and similar service where very heavy units must be frequently started without shock.

Clutch Installation—From a maintenance standpoint, serious consideration should be given to the choice between the solid or split types because, with the average clutch, wear is rapid; therefore, the convenient removal of the clutch from the shaft is important. The solid clutch should be used at or near the end of a lineshaft or on short headshafts where it can be readily removed without disturbing other elements. The split clutch should be used on a lineshaft or on short shafting where it is impossible to slide the clutch from the end of the shaft. When using a split clutch, the driving member on the sleeve,—pulley, gear or sheave—should be split, also; otherwise the split feature of the clutch is defeated.

The matter of bearing spacing is an important item in clutch installations. The average clutch, should not be placed midway between bearings spaced on 6- to 8-ft. centers, because of the possible deflection of the shaft. One bearing should be immediately adjacent to the clutch for average loading. For heavy loads, necessitating a large, and heavy clutch, a bearing adjacent to each side of the entire clutch drive should be installed.

There are various methods of controlling the operation of a clutch, the most common being the yoke and lever. This method is successfully employed up to 50 hp., but for powers beyond this convenient and efficient gearing and lever systems have been devised. These control devices should be placed in accessible and convenient locations, because the immediate release of a clutch is often necessary.

A typical split-clutch, pulley-driving installation is shown in Fig. 10. The pulley is of the split type, clamped or keyed to the sleeve of the clutch. The same installation is suitable, as shown in Fig. 11, for either gear sprocket, or sheave. Fig. 12 illustrates a typical sleeve-clutch installation The clutches are solid, because removal can readily be made from either end of the shaft. It will also be noted that three bearings are used on the short shaft, because the concentrated dead load of the clutches and driving wheels is heavy. Clutches of this size are operated, as shown, by a gear and segmental-rack mechanism. Fig. 13 shows another typical, heavy clutch installation.

Clutches in Duplex—It is frequently necessary, in transmitting power, to reverse the direction of rotation quickly. This can be done by sliding an open and crossed belt on a drum pulley to two tight and one loose pulley on the driven shaft, but when properly arranged the friction clutch functions more efficiently for this purpose. Manufacturers of clutches have arranged the toggle or shifting mechanisms of clutches so that the clutches can be assembled in pairs or in duplex and controlled by one lever or gear-shifting mechanism.

A typical arrangement of clutches in duplex on a machine tool countershaft is shown in Fig. 14. The sleeve of each clutch is equipped with a pulley, from one of which is operated an open belt and from the other a crossed belt. The clutches are arranged so that a single collar controls the toggle mechanisms of both.

In Fig 15 is shown another type of clutch arranged in duplex for apparatus whose direction of rotation must be reversed.

Friction Cutoff Clutch — This mechanism, sometimes termed a friction cutoff coupling, is similar in construction to a regular friction clutch with the exception that it has no sleeve. It is used chiefly for connecting together two lengths of shafting so that one section can be stopped or started at will while the other section is operating.

The cutoff clutch is also a most effective means of preventing accidents and injuries to workmen by making possible the immediate stoppage of the shafting and machinery.

The matter of bearings adjacent to friction cutoff couplings is most important. A bearing should always be installed immediately adjacent on each side of such a mechanism, because when a clutch of this character is disengaged there is no connection between the two ends of the shaft; therefore, they must be well supported. This type of clutch is controlled in a similar manner to the regular friction clutch, light powers requiring the yoke-and-lever method, whereas heavy loads should be controlled by the pinion-and-rack system.

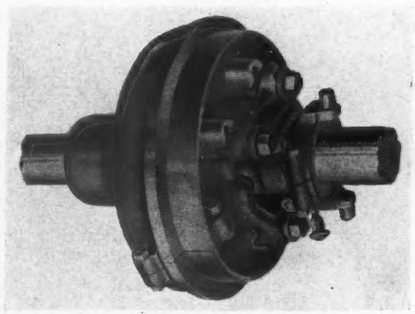


Fig. 16—Split type of friction cutoff clutch.

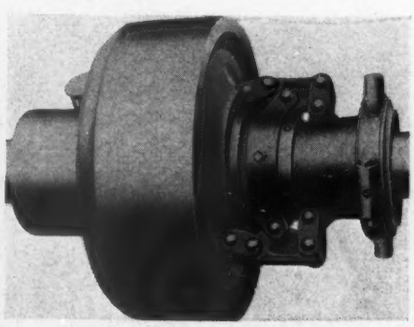


Fig. 17—Solid type of friction cutoff clutch.

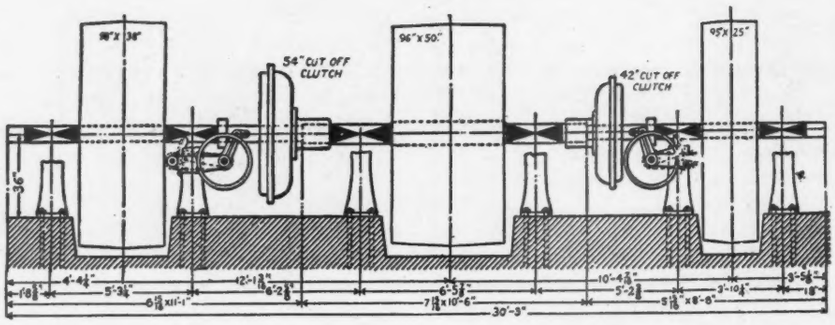


Fig. 18—Typical installation of friction cutoff clutches.

A typical split-type cutoff clutch is shown in Fig. 16, and Fig. 17 shows a typical solid type. Fig. 18 illustrates one of the functions of the friction cutoff clutch. The power is applied to the central pulley and the clutches are arranged so that to change the power distribution from one side to the other, it is only necessary to engage or disengage one of the cutoff couplings

Jaw Clutches—The jaw clutch provides a convenient method of connecting or disconnecting a load where shock is of no consequence and the speed is low; therefore, it is most generally employed for heavy, rough driving. It should not be considered for the average industrial transmission system. It is considered unsafe to use this type of clutch on speeds exceeding 60 r.p.m. for the average power requirements, because there is no gradual picking up of the load; furthermore, beyond this speed it is most difficult to engage the clutch. A square-jaw clutch with extended sleeve is shown in Fig. 19. This sleeve can be equipped with any driving member required, such as a pulley, gear, sprocket, or sheave.

Where frequent engaging and disengaging are necessary, the jaw clutch should not be considered, because of the continuous shocks of engagement. When selecting a jaw clutch, the frequency of operation should determine whether the spiral or square-jaw type should be employed; square, if almost permanent connection, and spiral if it is operated at certain intervals. The spiral type, Fig. 20, is easier to engage and disengage than the square jaw.

Jaw Cutoff Clutches—This clutch is of similar construction to the regular jaw clutch with the exception that it has no sleeve and acts as a connection between the ends of lineshafting for heavier loads than the friction cutoff coupling will handle satisfactorily. With low speeds and on dusty, gritty operations it can be successfully employed for permanently connecting and disconnecting power shafting. Where this type of clutch is used, it should not be connected or disconnected when operating at speeds higher than 60 r.p.m. However, it can be used at higher speeds, because it is generally possible to shut down the shafting while the engagement or disengagement is made.

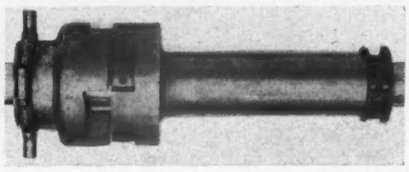


Fig. 19—The square-jaw clutch with sleeve.

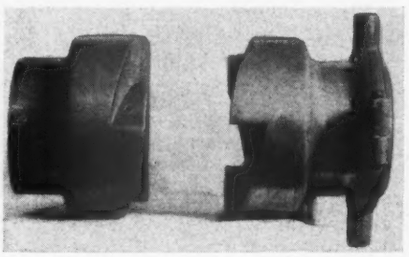


Fig. 20—Spiral type of jaw clutch.

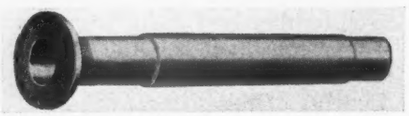


Fig. 21—Here is one type of cast-iron quill.

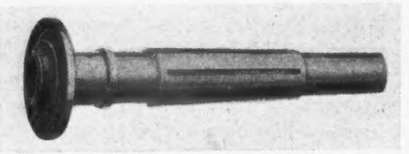


Fig. 22—Another type of cast-iron quill looks like this.

In an installation of this character, it is imperative that bearings be placed adjacent to each side of the jaw cutoff clutch, because there is no connection between the ends of the shaft when the clutch is disengaged and connection is impossible if the shaft is not in alignment.

Quills—The average friction-clutch sleeve is subjected, when under load, to the same stresses as a cantilever beam, as it is rigidly supported on one end only, the opposite end having a slight running clearance on the shaft. Where a large pulley, gear, sprocket, or sheave is required and heavy power is involved, a quill or hollow shaft is employed in connection with friction clutches, instead of a sleeve.

A quill is supported on its own bearings and is independent of the main driving shaft which runs through it. When the clutch is thrown out of engagement the weight of the driving elements as well as the belt strain is taken from the lineshaft properly by the quill.

Quills are generally made of cast iron, but in certain cases where the service is extremely severe and heavy wheels must be carried, they are made of forged steel. Average types of cast-iron quills are shown in Figs. 21 and 22. Quills are always used with 36-, 42-, 48-, 54-, 60-, and 72-in sizes of friction clutches, and when loads are extremely heavy they are frequently used with smaller sizes.

The quill functions efficiently when it is desired to start a prime mover, such as a motor or steam engine,

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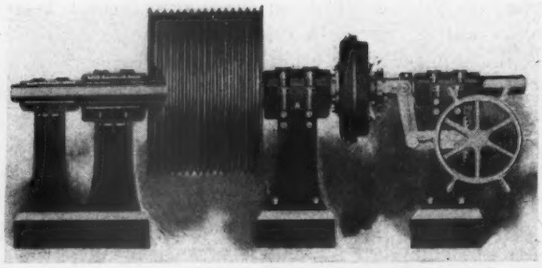


Fig. 23—One form of quill installation. Note that the quill connected to the clutch turns in bearings that are independent of those on the main lineshaft.

Fig. 1.—Involute end winding used with open slots, one coil side per slot.

Replacing *an old* Involute Winding *by the diamond two-layer type*

By A. C. ROE

Renewal Parts Engineering Dept.
Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

THE type of winding illustrated in Fig. 1 is known as the involute and is used with open slots, one coil side per slot. The coils are all of the same shape, and are completely insulated before installing. Also, in the majority of cases, round wire is used to wind the coils to their final shape on a mold. In some few cases bare copper strap is used, but this article will be restricted to a discussion of the wire-wound type.

The characteristics of this winding are, chiefly, short coil end extensions parallel to the shaft, and end windings of greater radial depth; the coils are full, and in some cases over, pitch. The general shape and large number of bends make this an expensive coil to produce. These points can be verified by a study of the involute coil shown in Fig. 2.

Another fact that adds to the expense of making is that, for designs having two or more conductors widthwise in the slot, single coils must be wound and assembled into the complete unit. This procedure has the disadvantage of increasing the difference of potential between sections or single coils, when all the turns per slot are in series.

Another disadvantage of this winding is that with wire larger than 0.102 in. diameter, a separate mold is required for each section, or single coil; this is necessary to insure that the coils will fit together properly at the bends. Thus, this type of winding may require as many as four molds, although the complete winding units are all the same size and shape.

Figure 3 shows two molds being used to wind a two-section involute coil, each section consisting of eight turns of one 0.182-in. triple-cotton-covered wire, the two sections being connected in series and making a sixteen-turn coil.

One of the peculiar features of this coil, which is that the outside turns must be wound into place first, is shown in Fig. 4. At the corners of the bottom slot section in Fig. 4 two turns are being held up by means of a radius block, one block being required at each corner and for each turn. This is true of any mold-wound involute coil regardless of whether it is wound to shape or wound into a double-drop shuttle and spread open in a subsequent forming operation.

Two single coils or sections assembled together are shown in Fig. 5, which also illustrates the reason for the additional molds. The points marked R_1 to R_8 indicate the eight points or bends where a radius block is used to form the wire. Then, numbering the single coils *1* and *2* as shown, one mold will be required for coil *1* with a ½-in. radius at R_1, R_3, R_4, and R_6, and a ¾-in. radius at R_2, R_5, R_7, and R_8. Then mold No. 2 will have a ½-in. radius at R_2, R_5, R_7, and R_8, and a ¾-in. radius at R_1, R_3, R_4, and R_6, the change in radius being due to one-half of coil *1* fitting inside of the bottom half of coil *2* and outside of the top half of coil *2*, as Fig. 5 shows.

As might be expected, this is one of the most difficult windings to change over to the modern diamond, two-layer pulled coil type but the results and subsequent savings justify

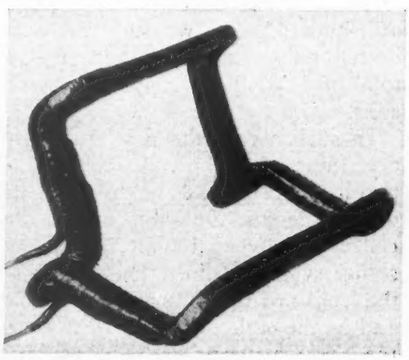


Fig. 2.—Involute type of mold-wound coil.

the effort. In every case the coil pitch must be chorded, the over-all length of the coil being the factor that determines what the coil pitch shall be, as the length and pitch govern the winding angle of the coil ends.

The following example of a changeover made on an involute winding will indicate what can be accomplished. The winding was for

Fig. 3.—Double molds used to wind the two sections of an involute coil.

a rotating-field, a. c. generator rated at 450 hp., three phase, 25 cycles, 6,600 volt, 500 r.p.m., six poles, 31½ amps. per terminal.

The winding had 90 slots and 45 involute, 3-section coils each section or single coil having 11 turns of one 0.144-in. diameter triple-cotton-covered wire. All sections were connected in series, making a total of 33 turns per complete coil, with a pitch of 1-and-16. The winding was connected series-star, and there was a total of 1,033 lb. of copper in the 45 coils.

In such a case the first step is to determine what the coil pitch of the two-layer coil must be to keep its over-all length the same as the old coil. The over-all limit in this instance was 27¼ in. This was also the length of the top part of the coil, and as the ends dropped down along the core, a space between the coil ends and the core was necessary to protect the ends; this resulted in long slot sections, which in this case were 23¼ and 17½ in. The length of the core was 10½ in.

For a two-layer winding in the same core, the slot sections can be 14½ and 15½ in. long. The width of the old coil in the pitch direction was 23½ in.; dropping one slot at a time, a pitch of 1-and-11 gave an over-all length of 26¼ in. and a width of 16¾ in.

The next step is to check the turns

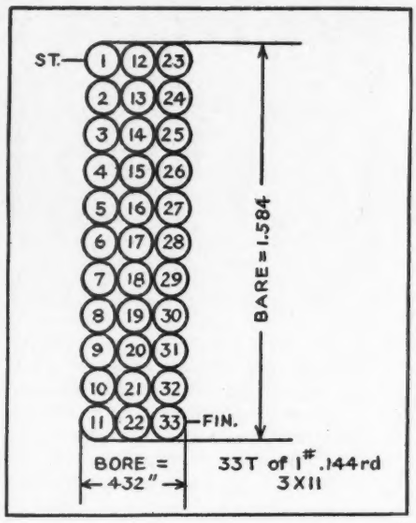
Fig. 4.—With involute coils the outside turns must be wound into place first. Here two turns are being held up by radius blocks, at the corners of the bottom slot section.

and the effect of the new pitch. The old winding had 33 turns per coil at full pitch; then the pitch of 1-and-11, or 10, would reduce the effectiveness of the turns. The amount of this reduction is determined by the chord factor, which equals 90÷6 =15, and 180÷15=12. Then the sine of (10x12)÷2=sine of 60 deg. or 0.866.

Thus, the effective turns equal 33×.866=28.578, or with a pitch of 1-and-11 to obtain the same effect as 33 turns at 1-and-16 pitch, there must be 33÷.866=38 turns. However, for a two-layer winding this would mean 38÷2=19 turns per coil, and as the arrangement in the slot is three wide, 19 turns would result in an extra layer of 1 turn. It was necessary, therefore, to use 18 turns, which is about 6 per cent less and would be satisfactory.

Next, figuring the cross-section of the new conductor, Fig. 6 shows the arrangement of the conductors of the original winding, and Fig 7 the new coil arrangement. Then, 1.584÷2= 0.792 in., which is the space available for six conductors, or 0.792÷6 =0.132 in., but with the method of winding used in Fig. 7, extra insulation was required between layers or turns *1* and *6*, *2* and *5*, and *3* and *4*. Therefore, the copper size must be less than 0.132 in.

From the wire table, it was found that one 0.144-in. round wire has an area of 20,700 circ. mil, and that a 0.129-in. square wire has an area of 19,951 circ. mil, which is 3.6 per cent less. However, the total length of copper was less and the heating should be less; so 0.129-in. square wire was used as shown in Fig. 7.



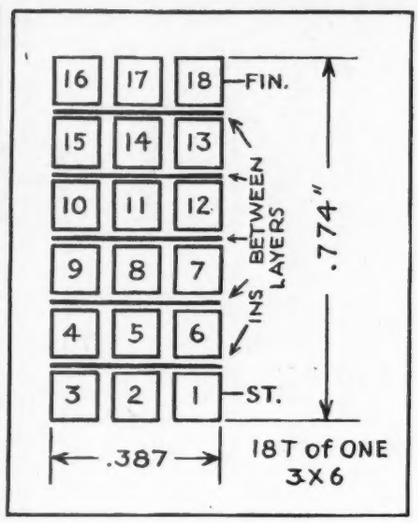


Fig. 6 *(Left)*.—Arrangement of conductors in original involute winding.
Fig. 7 *(Right)*.—Arrangement in new, diamond, two-layer winding.

The old winding had 1,030 lb. of 0.144-in. round wire. This corresponds to a length of 16,337 ft. The new winding had 650 lb. of 0.120-in. square wire, which equals 10,740 ft. In other words the new winding has 380 lb. or 5,597 ft. less copper.

The effect of this copper reduction on the heating can be calculated approximately by assuming 1 ohm per circ. mil-inch of copper at 65 deg. C. Then the resistance of the old winding equals (16,337×12)÷20,700= 9.47 ohms. Calculating it per phase, 947÷3=3.16 ohms. The voltage drop per phase equals 31.5×3.16= 99.54, and the full-load resistance loss equals 99.54×31.5=3,135.51 watts.

Then the resistance of the new winding equals (10,740×12)÷19,-951=6.49 ohms, and the resistance per phase equals 6.49÷3=2.163 ohms. The voltage drop per phase equals 31.5×2.163=68.13 volts, and the full-load resistance losses equal 68.13×31.5=2,146.09 watts; 3,135.-51—2,146.09=989.42 watts less. In other words, the losses due to resistance only have been reduced about 30 per cent.

From the above it follows that changing an involute winding to a modern type not only lowers the cost of the coils, but results in power savings and improved operation.

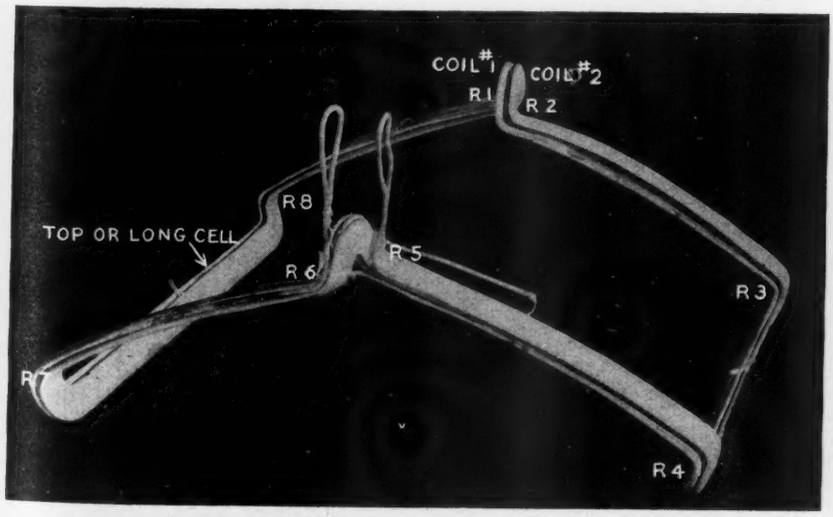


Fig. 5.—Two single coils or sections, *1* and *2* assembled together to form a complete winding unit.

WHY should men operating similar plants each have to make the same original experiments and usually the same mistakes? The day of industrial secrets is practically over. There is more to be gained from a free exchange of experience than from special little tricks, jealously guarded, as in former days. Industries, to prosper, must broaden both their knowledge and their sympathies. The so-called good old days have passed when the individual could, and often did, defy everyone else in the same industry and follow his independent course, neither giving nor receiving information. Manufacturers in other countries have learned that a free interchange of technical experience pays all concerned. A large share of the recent rapid development of the steel industry has been due to the partial adoption of this plan and to the free interchange of experience, but we have not gone far enough.—W. H. WARREN, *Gen'l Supt. Lukens Steel Company, Coasteville, Pa., before Association of Iron and Steel Electrical Engineers.*

AROUND THE WORKS

THIS SECTION *is especially devoted to short articles describing ideas and practical methods devised to meet particular operating conditions. The items may refer to mechanical details of installation, inspection, testing, wiring, repair, maintenance, replacement, and emergency or unusual installations of equipment tributary to production. Special attention is given to shop or bench tools and short cuts or improved methods of handling work brought into the repair shop. Contributions from our readers are always welcome.*

* * * *

Use of Lamp in Fuse Block to Indicate Short Circuit

WHEN a short circuit exists in a lighting feeder, an electric bulb may be used as a tell-tale signal in the fuse block. Simply unscrew the blown plug fuse and insert the lamp in its place, making sure that the other side of the circuit has a good fuse in it. Go over the entire circuit and turn off the individual lights. If the lamp in the fuse block burns at its accustomed brightness there is a direct short circuit on the line, and when it is located and removed the lamp will go out.

It is important that the individual lamps be all turned out, or the signal lamp will burn anyway, although dimly, for in this latter case the test lamp will be in series with any other lamp that remains connected into the circuit.

JAMES P. MARSHALL.

Providence, R. I.

Determining Full-Load Current on 1-Phase Transformers

A LOGARITHMIC scale chart can be used to show the relation of terminal voltage and full-load current for distribution transformers of the usual kilovolt-ampere rating. As the efficiency of ordinary transformers is from 96 to 98 per cent, both high- and low-voltage sides may be assumed to have the same rating. This assumption merely neglects the losses and for most purposes will not introduce a very serious error.

The kilovolt-ampere rating of a transformer represents the voltage multiplied by the amperes and the product divided by 1,000. Obviously, the output will equal the input if the losses are neglected. The output is equal to the input minus the losses, or the input is equal to the output plus the losses. If either of the two terms is known the other may be calculated. Also, the efficiency in per cent is equal to the output divided by the input, times 100. Likewise, if any two of the three terms are known the other may be found. With the aid of the above rules several things may be determined concerning any transformer.

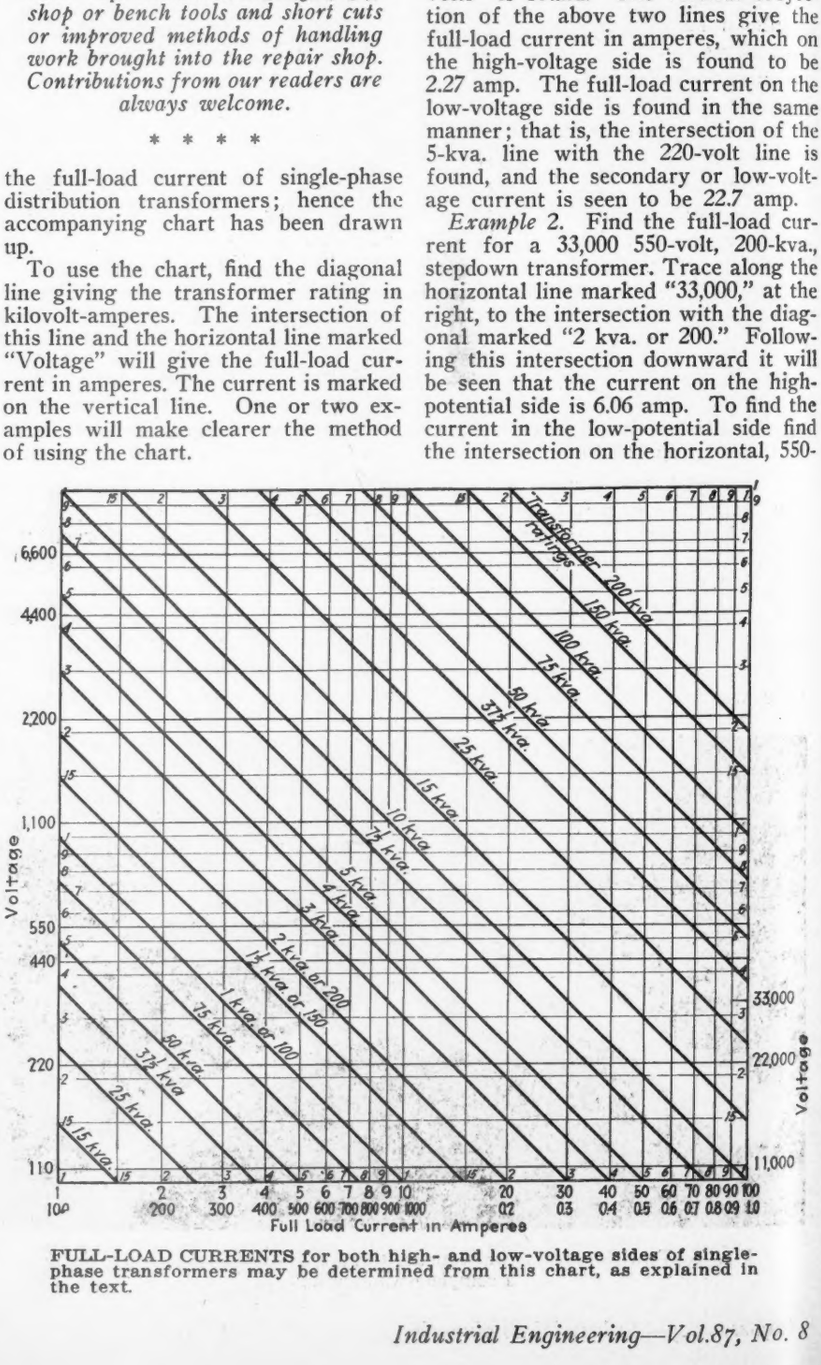
In making calculations for the voltage drop in distribution lines it is not necessary, however, to carry the calculation out to more than three significant figures; other factors entering into the solution of the problem make it meaningless to do so. In checking the size of wire to use, it is desirable to have an easy method of determining the full-load current of single-phase distribution transformers; hence the accompanying chart has been drawn up.

To use the chart, find the diagonal line giving the transformer rating in kilovolt-amperes. The intersection of this line and the horizontal line marked "Voltage" will give the full-load current in amperes. The current is marked on the vertical line. One or two examples will make clearer the method of using the chart.

Example 1. Find the full-load currents on both primary and secondary sides of a 2,200- 220-volt, 5-kva. transformer. Assume that losses may be neglected.

The diagonal line marked "5 kva.," representing the rating, is found. Next, the intersection of this line and the horizontal line marked "2,200 volts" is found. The vertical projection of the above two lines give the full-load current in amperes, which on the high-voltage side is found to be 2.27 amp. The full-load current on the low-voltage side is found in the same manner; that is, the intersection of the 5-kva. line with the 220-volt line is found, and the secondary or low-voltage current is seen to be 22.7 amp.

Example 2. Find the full-load current for a 33,000 550-volt, 200-kva., stepdown transformer. Trace along the horizontal line marked "33,000," at the right, to the intersection with the diagonal marked "2 kva. or 200." Following this intersection downward it will be seen that the current on the high-potential side is 6.06 amp. To find the current in the low-potential side find the intersection on the horizontal, 550-



FULL-LOAD CURRENTS for both high- and low-voltage sides of single-phase transformers may be determined from this chart, as explained in the text.

volt line with the diagonal "2 kva. or 200" line. This point of intersection will be seen to represent 365 amp. on the low-potential side of the transformer.

If it is desired to find the current of a transformer of a different rating than is given on the chart, a diagonal line may be drawn which will satisfy the conditions. It will be noticed that the various diagonals are connected to the corresponding points on the two adjacent sides.

In some cases it may be necessary to draw two lines, if the first happens to be at one corner of the paper. Other voltages than those given on the chart may also be included and used in the same way as explained in the examples.

CHARLES F. CAMERON.

Rock Springs, Wyo

Practical Tips on Lubrication of Equipment

ON applications where hand oiling is necessary, a golden rule for the oiler to remember is that it is much better to apply a few drops of oil at frequent intervals than to feed large quantities only occasionally. When a bearing receives a large quantity of oil at intervals of once or twice a week, it will run for a time flooded with oil, but at the end of the period it may be dry, or practically so. That is particularly true when the bearing is slightly worn, as the oil will run out rapidly.

In ring-oiled bearings the ring sometimes stops turning when the shaft speed falls below a certain point, depending on the shaft diameter and the size and shape of the ring. The ring, therefore, requires especially close watching on drives that are sometimes operated at low speeds. Where the oil reservoir is filled too full, particularly if a high-viscosity oil is used, the ring may stop turning.

Numerous motor bearing failures have resulted from neglect to make sure that the oil ring was turning, as well as from failure of a two-piece oil ring. When the ring stops turning lubrication ceases. If enough heat is generated to melt the bearing metal, the shaft drops; and when the revolving armature or rotor comes in contact with the field poles considerable damage usually results.

W. E. WARNER.

Shefford, Bedfordshire, England.

Welded Angle Iron Carpenter Horses

MOST plants or shops can use a pair of carpenter's horses and indeed few places are without these handy accessories. The trouble with most carpenter's horses, however, lies in the fact that they are usually made of wood and have a tendency to break or spread after they have been subjected to hard usage.

The plant welder of a large Eastern shop, realizing these facts, constructed a pair out of some scrap angle iron.

ANGLE IRON CUT to length and oxwelded as shown here serves a useful purpose in the form of carpenter's horses.

* * * *

The finished product was a great improvement over the wooden ones that had been used in the past.

It was a simple task to oxweld these pieces of scrap together. The accompanying illustration clearly illustrates the construction of the horse and the location of the welds. The pieces were all welded with butt-type joints and a small amount of welding rod added for extra strength.

Trouble with Generator Due to Shifting Brush Yoke

AN interesting experience some time ago taught me several things, among them that one must sometimes look in the most unexpected places for trouble before giving up a job.

A commercial repair shop had to install a new set of reaction brush-holders on a generator that was rated at 800 amp. and commonly carried 1,000 amp., although it was sparking badly. The brush-holders had to be installed between Saturday noon and Sunday afternoon, with a heavy forfeit if the machine were held up longer.

On Monday the installers reported that after working continuously from Saturday noon until Sunday afternoon they had been forced to put the old equipment back to keep the machine operating. When the new equipment was on, the generator voltage came up properly, but when a load was applied the voltage dropped off sharply, coming to about half normal at one-third load, although there was no sparking.

On a later Saturday I was present when the new equipment was again placed on the generator and to my astonishment the machine acted as the installer had reported, although as I expected, using three different grades of brushes made no difference in its behavior. Again, we had to put on the old equipment to get normal operation.

The makers of the machine were politely incredulous when I told them how the machine behaved and sent a practical man out with their engineer. We put the new brusholders on very carefully and then started up, with the same results as before, to the engineer's great surprise. Once again we had to put on the old equipment to get the machine back into service.

For weeks we tried to find out what was the trouble with that machine. Finally, a good practical man got under it, and discovered that in shifting the yoke the lead was pulled in such a manner as to short circuit the series field. There was a difference in the throw of the two sets of brush-holders, so that in order to keep the brushes in the neutral position the yoke had been shifted a little each time a change had been made. Thus the old set of brushes had the benefit of the compounding, but when the new brush-holders were installed the series field was shunted out every time. This particular generator would not hold up its voltage at all as a shunt machine.

It was a simple matter to remedy the trouble, and the generator now gives full voltage without a spark on any load that the engine will pull.

Engineer,
The Baylis Company,
Bloomfield, N. J. EDWARD D. CARTER.

Repairing Cast Iron Pulley with Broken Rim

WHEN a cast-iron pulley was broken in a plant that was located in a small town many miles from any city where a new pulley or a welding outfit could be secured, we avoided a serious shutdown by repairing the pulley through the medium of a steel band that was shrunk on over the rim.

We made the band ¼ in. thick and the full width of the rim on the pulley. The inside diameter of the band was made about .008 in. smaller than the outside diameter of the 12-in. pulley. To make sure that the band would not move after being shrunk in place we put ⅜-in. copper rivets 6 in. apart around the rim, being careful not to crack the pulley while riveting. The job was finished in a comparatively short time and worked satisfactorily.

When making a repair of this sort the condition of the pulley and band must be taken into consideration in making the shrink fit. If they are not round or have high or low spots an allowance will have to be made. Care should also be taken to see that the crack lines up with the face of the pulley before the band is applied. If this is not done the band will distort the pulley, and be loose. This alignment can be insured by using a steel or iron clamp (a wooden clamp will burn) to hold the band to the rim of the pulley at the broken joint, allowing it to cool in this position. Rivets should be placed on each side of the break through the rim of the pulley and the band.

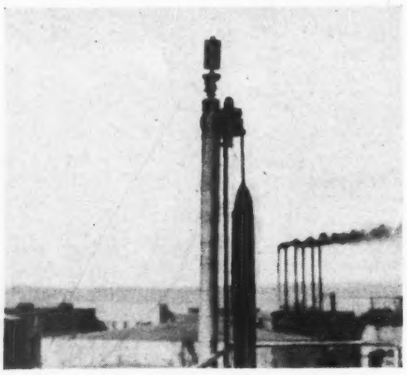
If the pulley is crowned the crown can be cut off by grinding, or turned down in a lathe. If a crown is necessary on a finished pulley it can be placed in a lathe after the band is shrunk in place and crowned as before. However, it is necessary to make sure that the rivets are countersunk deeply enough in the band to allow for the stock coming off for the crown.

Denver, Colo. R. M. THOMAS.

Electrically-Controlled Whistle Serves as Code Call

A STEAM signal whistle in the yard of a large oil refinery in the Rocky Mountains is used to summon certain members of the organization to the telephone.

The electrical impulses which govern the blasts of the whistle originate in an Autocall telephone-type switchboard. This switchboard, with its code mechanism, is connected to the solenoid of a General Electric magnetic switch, the contactors of which close a circuit that energizes a solenoid-operated valve. The whistle valve



THIS STEAM WHISTLE, controlled by a solenoid-operated valve, is used to call important employees of an oil refinery to the telephone.

* * * *

originally used was operated by a home-made solenoid device which required approximately 2 kw., whereas the present equipment consists of a balanced valve requiring less than .2 kw. to operate.

Originally the whistle and valve were mounted on a stack 115 ft. from the ground, but they have recently been remounted. As the demands on this signalling system are approximately 100 persons summoned per 24 hours, and as each signal is continuously repeated until the employe summoned reports by telephone to the switchboard, it was found desirable to replace the old outfit by a more efficient one.

Even though exposed to violent winds, snows, dust storms and temperatures varying from 30 deg. below zero to 110 deg. above, the system has functioned satisfactorily. The steam pressure used is about 100 lb. per sq. in., and the short blasts are sounded at the rate of four in five seconds.

Emergency Starter for a Motor-Generator Set

IN one large manufacturing plant two motor-generator sets are used to supply current for operating the cranes. These machines are direct connected, but are not arranged for parallel operation. The large set is of recent design and is rated about 275 kw., 275 volts. The small machine will not carry the full load of the plant, so when the large machine is down the plant cannot run at full capacity. The latter set is driven by a 2,300-volt synchronous motor.

Recently one of the auto-transformers burned up while this motor was being started and a spare was not available. The machine could not be brought to synchronism and, of course, the circuit breaker would not stay in. The electrician at once searched the repair shop at the plant for an impedance coil or something that would do in an emergency. There was nothing available except several sizes of series field coils for direct-current motors.

Eventually a coil for a 5- or 7½-hp. d.c. crane motor was selected. The wire must have been about No. 8 B&S and there were probably 15 or 20 lb. wound on about an 8-in. form. This coil was connected in series with the line in which the auto-transformer had previously been connected.

The machine breaker was thrown in, but when the starter handle was put in the running position the breaker came out again. Another attempt was made without any changes and again the motor failed to synchronize.

It was found later, however, that the current rose to a high value when the switch was first thrown in; then it would fall to a normal value and again start to rise. If the switch were thrown to the running position just before the second current rise the motor would lock in step and the breaker would remain closed.

The operator was accordingly shown just when to throw over to the running position by watching the ammeter, and this coil was used for starting duty for two or three weeks.

Such emergency impedance coils can be used for starters very successfully, if properly designed. In fact there is one company that manufactures them. They are simple in construction and give very little trouble as they are much easier to insulate than auto-transformers. I have made several starting coils like this, using wood cores and mounting the coils on a wood base. Of course, the bases are painted with an insulating paint and the coils are insulated for the voltage at which they are operated. When making the coils it is a good idea to bring out two or three taps so that the proper one can be selected by trial.

Birmingham, Ala. GRADY H. EMERSON.

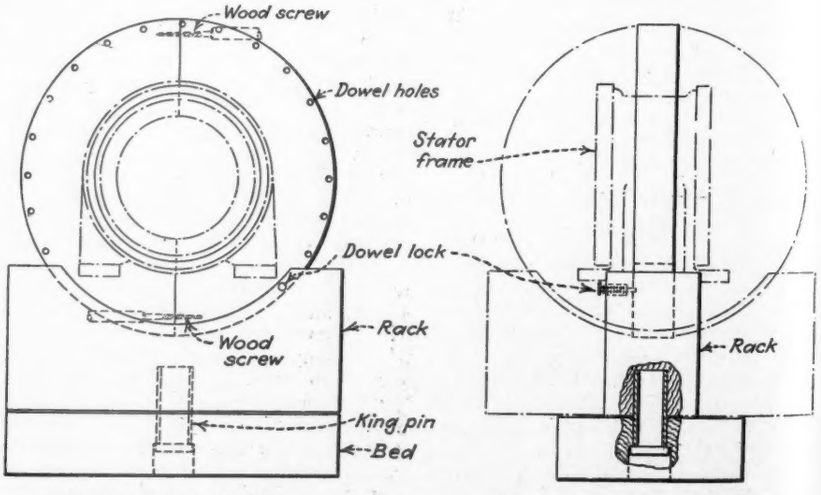
Frame for Holding Small A.C. Stators While Rewinding

IN order to speed up the rewinding of small motors I devised and have been using for some time the stator holder shown in the illustration.

The holder or frame, is made of hard wood and is split in halves, which are held together with two wood screws in the manner shown in the illustration. We have made a number of these frames to hold all sizes of motors up to 10-hp. rating. The frames fit into a rack, which has a groove cut in its top to permit the frame to revolve. In the edge of the frame are a number of dowel holes to permit the dowel lock to engage and lock the frame in any desired position to suit the winder. The rack is fastened to the bed by a king pin which permits the rack and frame to be rotated to any desired angle. The bed is either fastened to a winding stand or to the work bench, as desired.

It is our plan to make larger sizes of these frames that will take from 10- to 30-hp. motors, as soon as we can conveniently do so. However, for motors of this size the frame will have to be made from iron, which will, of course, involve a higher cost. However, it is believed that this cost can be justified by the increased facility with which rewinding can be done.

Kewanee, Ill. JOHN H. SCHOENBERGER.



THE STATOR is held between the two halves of the frame, which can be rotated and turned to any desired angle.

It Takes Us Three Days to Determine Yearly Costs

MONTHLY AND YEARLY COST SHEET

DEPT.	NO. OF MOTORS	TOTAL RATINGS OF MOTORS	COST OF REPAIRS TO MOTORS & EQUIPMENT		COST OF MAINTENANCE MOTORS & EQUIPMENT			COST OF ALTERATIONS TO MOTORS, EQUIPMENT & LIGHTS		LIGHTING COSTS NUMBER OF LAMP RENEWAL			TOTAL DEPARTMENTAL COSTS
			MATERIAL	LABOR	OIL	FUSES	LABOR	MATERIAL	LABOR	LAMPS	COST	LABOR	
A													
B													
C													
D													
E													
F													
G													
TOTALS													

COST PER UNIT MOTOR AND UNIT HORSEPOWER PER EACH COST ITEM. M=MOTOR: HP=HORSEPOWER

DEPT.			M	HP	M	HP	M	HP	M	HP	M	HP	M	HP	M	HP		M	HP	M	HP	M	HP
A																							
B																							
C																							
D																							
E																							
F																							
G																							
TOTALS																							

COST PER UNIT MOTOR, REPAIRS & MAINTENANCE ONLY = $
" " " HP, " " " " = $

Fig. 1—Cost sheet used for tabulating department costs per unit on a monthly and a yearly basis.

By H. E. STAFFORD

Electrical Engineer
Port Arthur, Ont., Canada

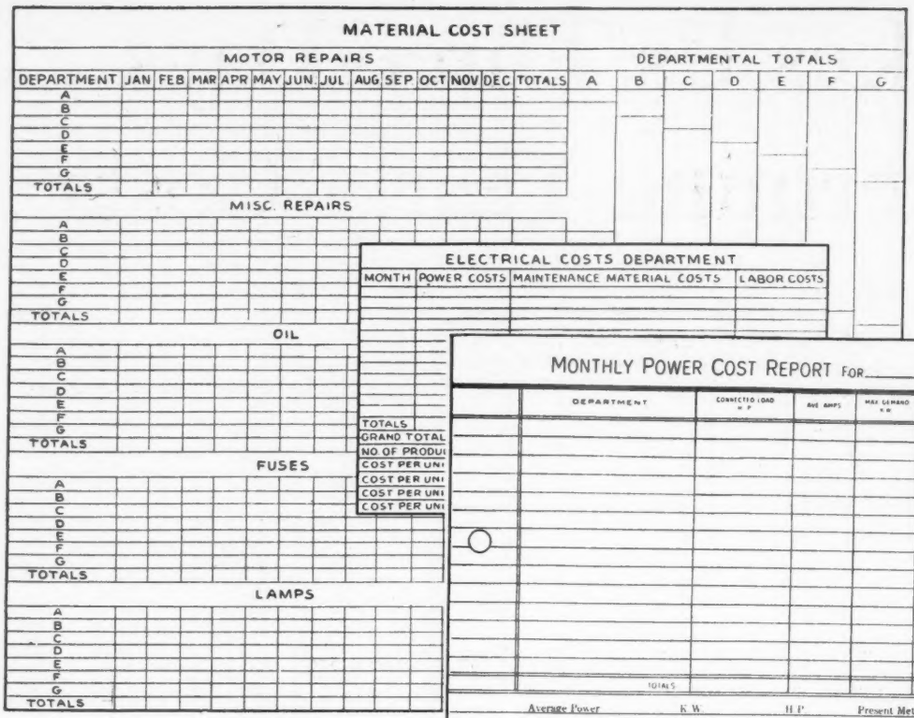
PROBABLY no one item gives an executive more satisfaction than the knowledge that his maintenance costs are a minimum, or are, at least, a little lower than those in some similar plant. Maintenance costs have always been a bone of contention and the bane of an executive's existence. On one hand, it is necessary to give equipment a certain amount of attention in order that it may properly function, and on the other hand, it is necessary to check up on the operator to see that the equipment gets a square deal. Maintenance costs can therefore be considered as being due to man-made equipment and man-handled equipment; the latter usually contributing to the greater share of the maintenance costs. If human beings could be taught to play fair and not abuse equipment, maintenance costs could be reduced to a minimum.

A great deal can be done toward reducing maintenance costs by systematic and proper supervision of equipment, especially where there are only a few machines involved, but where thousands of machines are operating twenty-four hours a day and six days a week, it is next to impossible to keep a close check on every piece of equipment and every operator at every instant.

About the next best method, therefore, is a close check on the costs, keeping each unit separate and each department separate. A point can be reached, however, where a cost finding system becomes unwieldy, and it is the object of this article to set down a system that has worked satisfactorily for some time, does not consume more than a few hours a month to keep up to date.

A system such as outlined will readily show if a given motor is costing more than it should and what steps are being taken to remedy it. For instance, a motor on a certain application is continually burning out. Is it always possible to know what it is costing to keep the application operating and what steps are being taken to remedy the trouble? In a case of this kind two or three burnouts should be convincing enough to show that a change in the location of the motor is necessary, or that a different type of motor is required. It should not require a cost finding system to determine this, but it is sometimes necessary to have a cost record in order to convince those higher in authority that there is something radically wrong about the installation in order to get quick action and remedy the trouble.

By means of the system which has been worked out and used at this plant, every item of cost as regards power, labor, maintenance and production is taken into consideration. The plant is divided into seven departments and each department cost per unit is kept separate and distinct. By means of the records, the cost of each unit of production is known against each item of expense to the minutest detail. Again, the cost per


MATERIAL COST SHEET

MOTOR REPAIRS

DEPARTMENT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
A													
B													
C													
D													
E													
F													
G													
TOTALS													

DEPARTMENTAL TOTALS

A	B	C	D	E	F	G

MISC. REPAIRS

A													
B													
C													
D													
E													
F													
G													
TOTALS													

OIL

A													
B													
C													
D													
E													
F													
G													
TOTALS													

FUSES

A													
B													
C													
D													
E													
F													
G													
TOTALS													

LAMPS

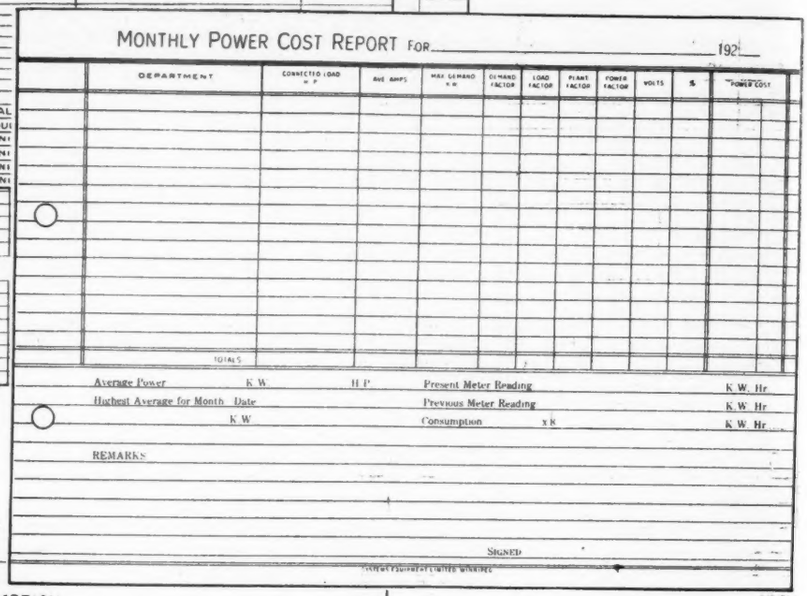
A													
B													
C													
D													
E													
F													
G													
TOTALS													

ELECTRICAL COSTS DEPARTMENT

MONTH	POWER COSTS	MAINTENANCE MATERIAL COSTS	LABOR COSTS
TOTALS			
GRAND TOTAL			
NO. OF PRODU			
COST PER UNI			
COST PER UNI			
COST PER UNI			
COST PER UNI			

Fig. 2—Material cost sheet for each class of material and for each department. This sheet is kept by months and it has extensions for a yearly summary.

Fig. 3—Data for the sheet shown in Fig. 2 is taken from the daily requisition forms at the end of each month, the totals of which are transferred to this electrical cost sheet.


MONTHLY POWER COST REPORT FOR _____ 192__

DEPARTMENT	CONNECTED LOAD H. P.	AVE. AMPS	MAX. DEMAND K. W.	DEMAND FACTOR	LOAD FACTOR	PLANT FACTOR	POWER FACTOR	VOLTS	$	POWER COST
TOTALS										

Average Power _____ K.W. _____ H.P. Present Meter Reading _____ K.W. Hr.

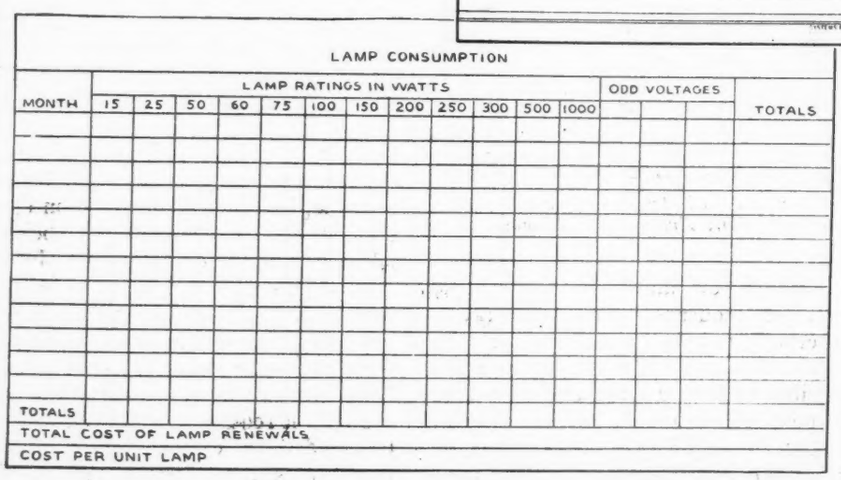
Highest Average for Month _____ Date _____ Previous Meter Reading _____ K.W. Hr.

_____ K.W. Consumption _____ x K _____ K.W. Hr.

REMARKS

SIGNED

Fig. 4—Monthly power cost report from which the power cost is obtained that is charged to each unit and to each department.


LAMP CONSUMPTION

MONTH	LAMP RATINGS IN WATTS												ODD VOLTAGES			TOTALS
	15	25	50	60	75	100	150	200	250	300	500	1000				
TOTALS																
TOTAL COST OF LAMP RENEWALS																
COST PER UNIT LAMP																

Fig. 5—Lamp consumption record from which yearly lamp contracts are figured.

motor and per horsepower in each department and for the plant as a whole is figured as to each item of cost, such as oil, fuses, inspection and maintenance labor, motor and control repair material and labor, cost of alterations to equipment and lamp renewals. Fig. 1 shows the cost sheet that is used for finding the costs for the foregoing items. This sheet can be kept for a day, a week, a month or a year, but it is hardly necessary to keep the records of anything less than a month, since it would involve a tremendous amount of useless work and the findings would not affect the savings.

A brief description of the various headings listed on the form shown in Fig. 1 will bring about a clearer understanding of the system. The items under cost of repairs to motors and equipment consist of the cost of rewinding motors, replacing bearings, the renewal of auto coils and contacts in starters, and, in fact, everything that is required for the apparatus itself, including labor.

The cost of maintenance for motors and equipment includes oil and fuses, the cost of oiling the motors, replacing fuses and the daily inspection of equipment.

The cost of alterations to motors and lights includes the replacement of all conduits and lighting equipment except lamps, replacement and renewal of all light extensions except lamps, the replacement of service switches, power conduits and cables due to changing motor sizes and applications, and, in fact, everything not confined to the repairs of motors and controls and the replacement of lamps.

Under lighting costs are shown the number of lamps used in each department, the cost of the lamps and the labor cost for renewing same.

The lower half of the sheet shows the unit cost per motor and per

horsepower for each and every item, while the two bottom lines show the unit cost for repairs and maintenance only.

With all the various costs in their proper places on the sheet, it is a simple matter to see which department or which item of expense is high or low, as the case might be, and also the reason for it.

The plant where this cost finding system is in use has 300 motors of all types, sizes and voltages: Alternating-current motors from 1/10 to 1,400 hp., 110 to 550 volts, and d.c. motors from 3 to 150 hp., 110 to 250 volts. Five men are employed in the maintenance of these motors; this crew doing the motor winding, oiling, repairing and construction and other miscellaneous work.

The cost per motor for the current year was $22.23 for repairs to motors and controls, which cost includes labor, while the cost per horsepower for the same items was $0.438. The cost per motor, including all items in Fig. 1, was $43.50, while the cost per horsepower was $0.847. These motors operate practically 310 days a year for 24 hours per day, and approximately 60 per cent of them are in locations subject to dampness, acid fumes, gases and other foreign elements.

There are motors in this plant on which the total maintenance cost did not exceed $31.08 per motor and $0.21 per horsepower. The largest single item of expense was for oiling and inspection. In one department the cost per motor averaged $128, while the cost per average horsepower was $6.10. This high cost was due to the rough usage of motors and equipment, since they were all outside and operating in temperatures as low as 30 deg. F. below zero, and were being continually shifted from one place to another. The cost of material and labor for alterations alone being $63.03 per motor and $3.01 per horsepower. The total cost per motor, including purchased power, was $825.57, while the total cost per horsepower for the total connected load was $16.07.

Fig. 2 shows the material cost sheet by months for each class of material and for each department with extensions for a yearly summary. The data for this sheet is taken from the daily requisition forms at the end of each month. The totals are then transferred to an electrical cost sheet shown in Fig. 3.

This sheet includes the cost of purchased power, all miscellaneous material, including lamps, oil, fuses, and labor. The power cost is taken from the monthly power cost sheet shown in Fig. 4, while the labor cost is taken from the payroll. Each employee makes out a time sheet for each day showing what department or motor the time is charged to.

The lamp consumption record is kept on a form shown in Fig. 5. It shows the number of each size of lamp used. This record is convenient in figuring the basis of the next year's lamp contract.

The annual power report shown in Fig. 6 is a summary of all cost sheets together with the production reports, station load, connected and average loads, maximum and average demands, load factor and the power required for each production unit and for each department.

The system does not require the services of an expert accountant and, as stated previously, requires approximately a day a month to keep it up to date, and about three days at the end of the year to make up the final statement. Also, records are kept which show all of these costs graphically. The use of this system has been the means of locating and stopping leaks in the various departments, and has also been the means of getting quick action; whereas a suggestion not backed by facts and figures would receive scant attention.

Although the various sheets show only seven departments, any number may be used according to the division of production.

ANNUAL POWER REPORT			
YEARLY POWER COST			
YEARLY POWER CONSUMPTION KW-HRS.			
COST PER UNIT KW-HR.			
TOTAL YEARLY COST DEPT. "A"			
NUMBER OF PRODUCTION UNITS			
COST PER UNIT PRODUCTION			
TOTAL YEARLY COST DEPT. "B"			
NUMBER OF PRODUCTION UNITS			
COST PER UNIT PRODUCTION			
TOTAL YEARLY COST DEPT. "C"			
NUMBER OF PRODUCTION UNITS			
COST PER UNIT PRODUCTION			
TOTAL YEARLY COST DEPT. "D"			
NUMBER OF PRODUCTION UNITS			
COST PER UNIT PRODUCTION			
TOTAL YEARLY COST DEPT. "E"			
NUMBER OF PRODUCTION UNITS			
COST PER UNIT PRODUCTION			
TOTAL YEARLY COST DEPT. "F"			
NUMBER OF PRODUCTION UNITS			
COST PER UNIT PRODUCTION			
TOTAL YEARLY COST DEPT. "G"			
NUMBER OF PRODUCTION UNITS			
COST PER UNIT PRODUCTION			
AVERAGE LOAD IN KW.	HP.		
YEARLY MAXIMUM DEMAND	KW.		
AVERAGE YEARLY DEMAND	KW.		HP.
AVERAGE YEARLY CONNECTED LOAD		HP.	
COST PER HP. AVERAGE CONNECTED LOAD			
COST PER HP. AVERAGE LOAD			
ANNUAL LOAD FACTOR			
HP. PER UNIT OF PRODUCTION DEPT. "A"			
HP. " " " " " "B"			
HP. " " " " " "C"			
HP. " " " " " "D"			
HP. " " " " " "E"			
HP. " " " " " "F"			
HP. " " " " " "G"			

Fig. 6—The annual power report constitutes a summary of all cost sheets, production reports, etc., from which graphic charts are made that show the operating characteristics of the entire plant at a glance.

Vibration

and its effect on lamp filaments

By ALLISON J. THOMPSON

President
The Thompson Electric Company
Cleveland, Ohio

VIBRATION presents a very real problem in industrial lighting, due to the extremely delicate structure of the light-producing filament in the incandescent lamp.

There are two types of vibration which are particularly destructive to the lamp filament; the first, and apparently the most common, has a short wave length with a high intensity, producing a sharp impact, jolt or jar which breaks the lamp filament.

The second type of vibration has a very short wave length of high and rhythmic frequency producing a molecular agitation or disturbance in the lamp filament which in time will cause it to break just as a piece of wire may be broken by bending it back and forth a sufficient number of times.

Vibration may be defined as an intermittent and more or less rhythmic reversal of movement, along with a resultant conflict between momentum and inertia.

When a ball is projected through space, if permitted to proceed until the energy of the projecting impulse is exhausted, the ball will fall to the ground, and nothing happens. This will correspond to one wave length from one impulse. But if in the meantime the ball should strike something which stops its flight, the remaining portion of the wave length will be shattered into fragments, which will proceed through the opposing body impelled by the unexpended energy of the original impulse, gradually decreasing in intensity.

That is to say, vibration may be produced by a single blow or impact, as in the case just described or by the operation of a power hammer in a forge shop, jarring the ground around it, or by the impact of a falling body, by an explosion, or by any sort of impulse which jars or jolts a resisting elastic body or supporting medium.

Or, it may be produced by a cumulative synchronism of impulses which will have the effect of augmenting the vibration, whether it be caused by a dog trotting over a more or less flexible bridge, or by a series of impacts produced by machinery in operation. Such vibration will proceed through the structure or supporting medium, developing a momentum until it attains its maximum, and then will die out as in the first instance. The intensity and frequency of the vibration will vary with the intensity and frequency of the vibratory impulse.

THERE are six characteristics, or factors involved in vibration, *viz.:* wave length, intensity, frequency, rhythm, direction and the character of the vibrating medium—each of which has its own peculiar influence or effect upon the lamp filament, either by itself or in conjunction with one or more of the other factors. So it becomes essential to safeguard the filament with respect to each of these factors.

When the vibrating structure adjacent to the lamp is more or less compact and rigid, as in the case of various kinds of machinery, or other equipment, this second type of vibration may develop a very short wave length of high and rhythmic frequency, exceedingly destructive to the lamp filament. In this case it is obvious that the primary cause of the breakage is the rapid bending back and forth of the lamp filament, producing an alternation of stresses, rather than any sudden, sharp reversal of movement or impact.

The harder, more rigid or elastic the opposing body the farther the vibrations will carry, as may be illustrated by striking the end of a steel pipe with a hammer, and applying the same kind of a blow to the end of a length of garden hose.

A messenger wire is so pliable and resilient that it affords a very ideal support for a lamp, from the standpoint of protection against vibration, where that method of installation is practicable. About the only other method of protecting the filament is to insert some specially constructed resilient element between the source of the vibration and the lamp. Many devices, known as shock absorbers have been developed, which more or less effectively provide this desired protection.

As the principles applying to vibration will be the same on both sides of the resilient element, it follows that the weight of the lamp fixture is quite as important as the quality and design of the resilient element in the shock absorber. That is to say, upon the principle that the heavier a body is, the stronger the vibration will have to be in order to affect it; so the heavier the lamp fixture is, the more inertia it will have with which to "back up" or resist such vibration as may leak through the resilient element, just as on the other hand, the less the lamp fixture weighs, the more it will be affected by vibration.

For this reason there should be a proper balance or proportion between the resilient element in the shock absorber and the weight of the lamp fixture. The heavier the lamp fixture is, the larger the wire in the spring naturally must be, to give the lamp proper resilient support.

Inert stability, therefore, is a quality much to be desired in a lamp fixture, or in some element within the lamp fixture serving as a support for the lamp bulb as in the case of a street lamp in which the bulb stands upright above the socket, with a stabilizing inner element supporting the socket and bulb.

A shock absorber should be simple in design, rugged in construction, and must be adequate for the purpose which it is ready to serve.

QUESTIONS
Asked and Answered
By Readers

[HERE IS A PLACE *where you can get some inside information when you get stuck. The only condition is that you do a good turn to the other fellow when he asks a question that you can answer from your experience*]

Effect of Current Transformer Ratio on Watt-hour Meters

For determining load conditions and the power factor of three-phase, 220-volt, induction motors we are using two single-phase, watt-hour meters, two ammeters and a volt-meter, with current transformers having different ratio taps. The watt-hour meters read directly in kilowatts; that is, they have no dial constant. When used in connection with a current transformer having a ratio of 100-to-5 should the reading of the meter in kilowatts be multiplied by the ratio of the current transformers, 20-to-1, or must the register ratio be taken into consideration? Why? What formula is used to determine the true reading of a direct reading polyphase watt-hour meter which is equipped with a gear train for a certain transformer ratio and later is connected to transformers having different ratios?

Emaus, Pa. P. C. M.

Operating 60-Cycle Motor on 50 Cycles

Will readers please tell me whether it will be safe to operate a 300-hp., 2,300-volt, three-phase, 60-cycle, slipring motor on a three-phase, 2,300-volt, 50-cycle circuit? I understand that there will be a change in the speed and should like to know whether any other characteristics will be changed, as well as any precautions that should be observed in operating this motor on 50 cycles instead of 60 cycles.

Hannibal, Mo. D. M.

Removing Protective Coating from Pipe Before Welding

We are planning to install a welded pipe line but find that the pipe has been given a hot-dipped coating of a tar-like material which makes arc welding almost impossible. I wish that readers would tell me (1) whether there is any paint or similar coating that can be applied to the ends of the pipe before dipping to prevent the tar coating from adhering so strongly and (2) what is the most effective way of removing the protective coating before welding?

Los Angeles, Calif. J. C. W.

How Would You Treat a New Contract Like This?

Under an old contract I was charged $0.0112 per kw.-hr. for alternating current, less a deduction of ½ mill for the first 100,000 kw.-hr. no power factor penalty. An average bill reads:

30,750 kw.-hr. @ $0.0112	$344.40
152 kw. demand	$327.00
	$671.40
Less ½ mill per kw.-hr. on first 100,000 kw.-hr.	$15.38
	$656.02
Less 10 per cent on primary and secondary charges	$67.14
Net	$588.88

Under a new contract submitted it is proposed to charge me on a kva. basis of $0.0093 per kw.-hr. A sample bill for the past month has been presented as follows:

37,950 kw.-hr. @ $0.0093	$352.94
187 kw. demand	$362.00
	$714.94
Less 10 per cent on primary and secondary charges	$71.49
Net	$643.45

I notice that I get 7,200 kw.-hr. more at a difference in cost of $54.57. Will some readers answer this question; is the new contract more advantageous to me than the old one?

I am informed that my connected load is 159 kw. and the power factor 85 per cent. Why is the new demand 187 kw.? How much would I benefit by raising the power factor to 95 per cent? Would the saving warrant corrective apparatus? If so, shall I use static condensers or synchronous motors?

Houston, Texas. E. W. H.

Should Horsepower Capacity of Lineshaft Drives Be Limited?

Rearrangement of some of our departments and the addition of considerable new machinery has brought up the question of limiting the size of motors driving lineshafts. Ours is a metalworking shop; the larger machine tools are individually driven, but group drives are used for most of the smaller equipment. Our largest motors driving lineshafts are 40-hp. rating, but they will soon be too small. I understand that in some plants this is the maximum size used; when the load on one lineshaft exceeds this figure a new shaft is put up. I should like to know whether this is sound policy and wish the readers would discuss this question, telling what their policy is and the reasons for it.

Chicago, Ill. J. F. O'B.

Placing Primary and Secondary Circuits for Motor in One Conduit

A question has come up regarding the advisability of placing both the primary and secondary circuits for a 100-hp., 440-volt, 60-cycle, three-phase, wound-rotor induction motor in one conduit. I should like to know whether it is safe to do this and whether it is considered good or bad practice. Why?

McComas, W. Va. E. R. L.

Trouble in Welding Rotor Bars

We have had difficulty in welding the rotor bars of the 220- and 440-volt, three-phase, 60-cycle motors used on Sullivan CE7 mining machines. We have used both the acetylene and arc-welding processes, but cannot make the bronze we are using flow evenly on the copper bars. I shall be grateful for any suggestions that readers can give me on how to overcome this trouble.

Henrietta, Okla. K. O. B.

ANSWERS *Received to Questions Asked*

Operation of Three Generators in Parallel Gives Trouble

We are having trouble in operating the following units in parallel: units A and B are steam-driven, Western Electric generators rated at 250 volts, 100 kw., 250 r.p.m. They are six-pole machines, compound wound, with series shunt, but no interpoles. Unit C is a Diesel-driven Crocker-Wheeler generator, rated at 300 kw., 250 volts, 225 r.p.m. It is a compound-wound, eight-pole machine with interpoles and series shunt.

The equalizer cable from unit A to the switchboard is a 300,000 circ.mil cable 35 ft. long. The equalizer from unit B to the switchboard is a 300,000 circ.mil cable 28 ft. long, and the equalizer cable from unit C consists of two parallel 1,000,000 circ.mil cables 150 ft. long.

When units A and B operate in parallel, each takes its share of the load. When the load increases and unit C is put on the line, unit A begins to give trouble by not carrying its load. Varying the field rheostat does not help. We increased the speed of this unit, which gave a little relief, but did not overcome the trouble entirely. I wish that some reader would tell me whether it is possible to overcome this trouble by changing the series shunt on unit A. If so, just how should I go about it? R.W.

Garden City, L. I.

THE trouble that R. W. is having with his three generators is to be expected when two generators are identically the same and the third is of different design.

Some years ago I had to remedy the same trouble experienced with three generators when they were all operating in parallel. In this plant there were three units, one a 150 kw. machine which we will call unit *A;* unit *B,* of 250-kw., and unit *C* of 500-kw. rating. When unit *C* was put on the board and varying loads came on the line, units *C* and *B* would take most of the load. Unit *C* would take approximately 15 per cent more than unit *B,* and unit *A* would not increase its load more than 5 per cent.

However, units *A* and *B* would operate satisfactorily in parallel all the way up to full load; hence, I took it for granted that these two units must be all right and directed my efforts toward getting the proper shunt on unit *C.* After I obtained some German silver strips the proper shunt was made up and no further trouble was experienced at any load with all three generators on the board.

In R. W.'s case I believe that unit *C* is causing all the trouble and the installation of a shunt of the proper size on it will stop this trouble.

I would suggest that he obtain a number of german silver strips .025 x 2 in. x 8 in. and keep adding them across the series field lead terminal until the machine operates properly.

Shreveport, La. G. R. LIEBER.

IN REPLY to the question by R. W., inasmuch as units A and B operate satisfactorily in parallel by themselves, it is evident that the trouble is most likely in unit C, the 300-kw. outfit. My suggestion is that he proceed as follows:

1. Run each unit individually and determine whether the rise in voltage from no load to full load is the same.

2. Determine the resistance of the field circuits of units A, B and C, including cables.

3. Check the brush position on unit C.

On compound interpole machines, the interpoles themselves have a compounding effect, especially if the brushes are set slightly back of neutral.

If after making the first test R. W. finds that the rise in voltage from no load to full load is the same, he must be careful not to adjust the series field shunts on any machine, because all machines will be thrown out of adjustment by so doing.

The results of the second test should show that the resistance of the series field circuit of the 300-kw. machine is one-third that of the 100-kw. machine.

I am inclined to believe that the trouble will be found in the series field circuit of unit C, due to the relatively small number of turns compared to those in a straight, compound generator. That is, the resistance of this circuit is too low for successful parallel operation with generators of the old type. Increasing this resistance by inserting a resistance in the short leg of this series field, cutting out one of the 1,000,000 circ. mil cables, or placing an iron or german silver washer between the connecting lugs of this cable, will probably overcome the difficulty.

Bayonne, N. J. HUGH A. BLACK.

Should Extra Men Be Hired or Work Sublet?

In the December issue of "Industrial Engineering" the following question was printed under the above heading:

"I should like to get the opinions and experience of readers in different parts of the country on the following question. Assume that the chief electrician of an industrial plant is capable of installing all new equipment but has only a small force of men under him. When a big job is to be done, is it more economical or desirable to hire extra men at open-shop wage rates to install the equipment, than to sublet the work to an outside electrical contractor? Providence, R. I. W.D.B."

I wonder if you would be so kind as to reprint this same question and if you choose add my initials and request to those of W. D. B. The topic is of great interest to us. The answers published were very interesting, but we should like to see further discussion and hope that another printing of this question will bring out some additional replies.

Bakersfield, Colo. L.C.O.

THE question asked by W. D. B. and L. C. O. is interesting, and one that often comes up. Personally, I doubt very much whether any set rule can be established that can be relied upon; in other words, each particular case has to be decided when it comes up, taking into consideration whether the chief electrician can readily procure men who are used to working in the heat and in the hazardous conditions surrounding many jobs in industrial plants. The question of whether the electrical contractor has available men used to working under such conditions and capable of turning out the expected amount of good work is just as important.

In making a decision on such cases, one has to assume that the men to be hired by the plant are of the same caliber as those to be furnished by the contractor. Then, the matter simmers down largely to such questions as: Who is going to absorb the waste ends and left-over material? Is the job such that the contractor will be required to make a careful story to familiarize himself with the electrical layout of the entire plant in order to do justice to his particular work? Can the chief electrician of the plant find the time from his regular duties to supervise the work?, and so on.

Generally, it is safe to assume that the chief electrician, by looking after the work and doing it with men he has hired for the job, is saving for his company the profit which the contractor is justly entitled to when he does the work. Furthermore, the chief electrician has no one but himself to blame if the work is not done properly, so that maintenance costs begin to rise immediately.

This particular question relates only to electrical work, but in reality it is no different from a question as to whether the plant machine shop should do the mechanical work or sublet it to some local concern, or whether a carpenter should build his own house or let the job out to a contractor.

As a rule, I think the chief electrician will not go far wrong if he first asks himself which method he would choose if he personally owned the plant and was dependent upon the net earnings for his living.

However, when one attempts to answer such a question as this without knowing all of the conditions, he runs a risk of drawing conclusions that may not be applicable to all circumstances.

Chief Electrician, A. C. BARKER.
W. S. Libby Company,
Lewiston, Me.

ANSWERING L. C. O., the various possible solutions to every question of policy usually have their advantages and disadvantages. What may be the correct solution for this problem in one plant may be unsatisfactory in some other.

The policy of hiring extra men (meaning of course *capable* men) to help the plant's own employees on big jobs undoubtedly has the following advantages:

First, it is only natural that the employees of a plant will take greater pains to do the work in a thorough

ANSWERS *Received to Questions Asked*

manner. Second, perhaps this method would interfere less with production than when a contractor does the job. Third, the men who will eventually be responsible for the operation and maintenance of the equipment will have had an opportunity to familiarize themselves with it.

Against these points are two drawbacks: First, that the very magnitude of the installation may put it beyond the ability of the plant's force to handle it. Again, the contractor and his staff are probably especially trained and equipped to handle that particular kind of work and he has a contact with the equipment manufacturers which would undoubtedly enable him to secure speedier deliveries and better service than could be obtained by an individual plant. If the contractor is a reputable man he will be willing to assume the entire responsibility for the work, and so relieve the management of all worries.

The main objection that many executives have to letting work out on a contract is that the contractor expects to make a profit which the officials would like to keep in the treasury of their own company.

It is my opinion that the larger a plant is the more practicable it becomes for the regular force to do an increasingly greater amount of installation work, up to a certain point, beyond which the especially-equipped contractor should be called in. However, this is just the general statement of a personal opinion and as a principle may not be sound under all conditions.

Regardless of whether a contractor is doing the job, the plant engineer should always carefully inspect the work and check up on the materials and workmanship. It may also be well to point out that the plant management should beforehand investigate the contractor's financial responsibility and demand the posting of a satisfactory bond with a reputable surety company to cover his guarantee of the work for the full period of that guarantee.

Last, but by no means least, never, oh never, do any business with a contractor on the "cost plus" plan!

Denver, Colo. CARL A. WAGNER.

How to Keep Unused Paint

What is the best method of preserving unused paint so that it may be used later on? I have experienced a great deal of trouble and lost considerable good paint through lack of knowledge on this point.
Des Moines, Iowa A.M.

KEEPING paint in opened packages in good condition for future use *is* quite a problem, as others, besides A. M. knows. Yet, reduced to its simplest terms, it is possible to almost, if not entirely, eliminate loss in your paint purchases.

One plant engineer formerly bought his paint in wood barrels. He found this an unsatisfactory method unless he had sufficient painting to do to use it all. If a quarter or a third of the barrel was left over, the barrel in time began to leak, slopping up his storeroom and making an unsightly mess. Furthermore, the valuable liquid portion of the paint was largely lost. And finally, when he was ready to use it, he found a thick, heavy skin over the top, with a mass of partially dried-up pigment which was largely worthless. In the attempt to use it, his painter had to spend a half a day trying to put it in shape for application. Since then, he buys large quantities in five-gallon cans and has practically no losses. True, he pays slightly more per gallon for his paint, but the increased cost is more than offset by the savings he effects.

Generally speaking, wood barrels are not a satisfactory package in which to purchase bulk paint, unless one is sure to use it all up. If you should be in the position of having part of a barrel or five-gallon can on hand, then the best plan is to retain the head as nearly intact as possible, so that it may be replaced to keep out dust and dirt. Then, when ready to store it away, pour two or three inches of raw linseed oil over the top. A skin will form on the oil, it's true, but it will serve to keep the pigment soft and make it easy to prepare for use. When you open the package again, be sure to cut out this skin around the edge *and lift it out bodily*. Don't break it up and stir it into the paint. If you do, it makes it absolutely worthless from the standpoint of a good job. Unless the entire lot is strained the particles of skin stick to the brush or the surface you are painting and it is very difficult, if not impossible, to remove them.

Another point to bear in mind, after carefully removing the skin, is to pour off the liquid portion into a clean vessel. Then carefully work up the pigment remaining, using a clean, broad paddle for the purpose. Gradually add the poured-off liquid, adding turpentine or other thinner as may be necessary, until the entire contents are in a smooth, even consistency.

Another plant engineer pays a little more per gallon for his paint, but buys it in a steel drum with a removable head. This makes a tight package, readily handled, and minimizes his losses. Certain classes of material can also be purchased in a steel drum containing a mechanical agitator with a steel plug placed near the edge of the head. This permits proper stirring and with a "gate" screwed into the opening left by the plug, one can draw as much as may be needed.

Paints or varnishes which contain little or no pigment may be obtained in one-way steel drums, with a plug in the end or side. These packages are very satisfactory for that class of material.

Most plant engineers are standardizing on the five-gallon and one-gallon cans. While the price per gallon is slightly higher than the barrel figure, they accomplish a considerable saving over a year's time, due to greatly diminished or entirely eliminated losses.

Assistant Manager, ROY C. SHEELER.
Prescription Paint Service,
E. I. DuPont DeNemours & Company,
Philadelphia, Pa.

What Is the Best Method of Stopping This Crane?

I shall appreciate it if readers will help me solve the following problem. We are putting up a new crane runway, on which there will be three electric traveling cranes, two of which will be of 10-ton capacity, and one of 50-ton capacity.

The 50-ton crane is to operate only on certain sections of the runway, which will be reinforced. We do not want this crane to go on the part of the runway that is not reinforced, but the runway must be free of bumpers at each end of the reinforced section, so that the 10-ton cranes can work in this section.

Stopping of the 50-ton crane at the ends of the reinforced section must be effected electrically and automatically, and so arranged that by resetting the relay or some other device the crane can be moved back into its own section. How can this best be accomplished?
Vandergrift, Pa. G.J.K.

AS a simple and inexpensive solution of G. J. K.'s problem I suggest that he use two sets of power or trolley wires, one set on each side of the crane runway. Both sets should be mounted in the usual way and two sets of collector shoes or wheels employed on the 50-ton crane. The trolley wires on one side of the crane runway should carry power for their entire length. The trolley on the other side should be alive only over the section in which the large crane operates, having insulating sleeves cut into or placed over the wires so that the power will be cut off as soon as the shoes or wheels pass over the sleeves.

The feed from the trolleys to the controller should be carried to a double-throw safety switch, one side of which operates normally, whereas the other side of the switch makes contact only while it is held in by hand.

Ordinarily the large crane would operate with the double-throw switch in the normal closed position. If the operator should inadvertently drift past the reinforced section of runway, power would be cut off as soon as the crane passes over the insulating sleeve. In order to run the crane back into its own section, the operator would have to throw the double-pole switch to the other position, holding it in by hand against spring pressure, thereby taking power from the common trolley. Upon throwing the double-pole switch back into the running position the crane would be ready for operation again in its own section.

Beloit, Wis. S. W. STEARNS.

Flexibility and Ease of Operation *are obtained by* MODERN CONTROLS

By H. M. MYERS and J. M. WADE

General Electric Company
Schenectady, N. Y.

MODERN production methods, in combination with the increasing complexity of production machines, frequently give rise to motor drive and control problems that were unheard-of a decade or so ago. A good example of the part that modern control equipment plays in solving some of these problems is to be found in the drive for super-calenders described.

Super-calenders, which are commonly used in paper mills to give the paper a "finish," usually consist of a frame in which are mounted several alternate rolls of steel and compressed cotton, or steel and paper, in a vertical stack. Compound levers and weights are employed to obtain the required pressure between these rolls.

The bottom roll is driven by a motor and each of the upper rolls is driven through friction by the one below it. In general design all super-calenders are very much the same, differing only in the number of rolls and in the details of the refinements.

In this article we will consider the requirements for a super-calender drive in a coating mill finishing cardboard and similar papers such as are used for advertising posters. Cardboard of this sort is usually made from old paper and has little mechanical strength; therefore, it is more difficult to calender than stronger paper. For this reason the drive must meet the following requirements:

1. A slow or threading speed must be provided to enable the operator to "thread" the paper through the rolls or "stack" without danger of getting his hand caught between the rolls.

2. The equipment must accelerate smoothly from threading speed to normal calendering speed without breaking the paper.

3. On account of its low mechanical strength the paper may become torn or damaged on the edges or in the sheet itself during the coating process. These places are marked with paper tabs or targets as the roll is wound. It is necessary to cut or tear out such places so that only one thickness of paper passes between the calender rolls; otherwise the rolls themselves will be marked and require refinishing. Therefore, quick slow-down must be provided.

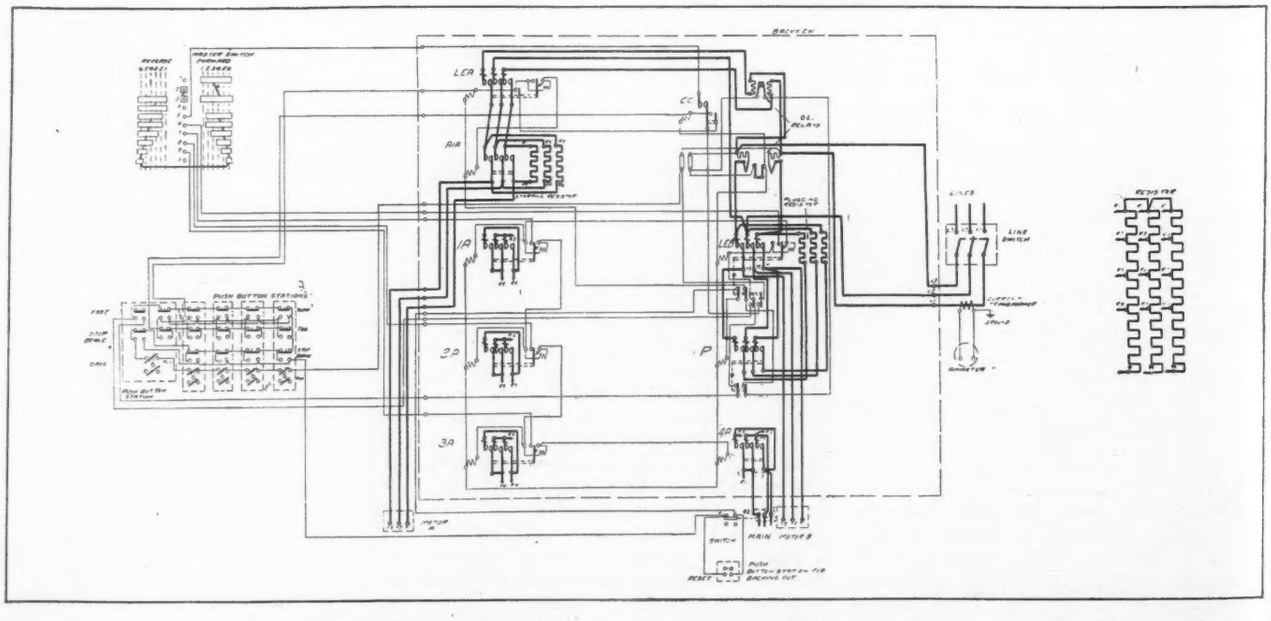
4. Rapid acceleration after slow-down must be obtained to prevent loss of production.

5. Adjustable speed — approximately 2:1 range—must be provided to take care of various grades of paper.

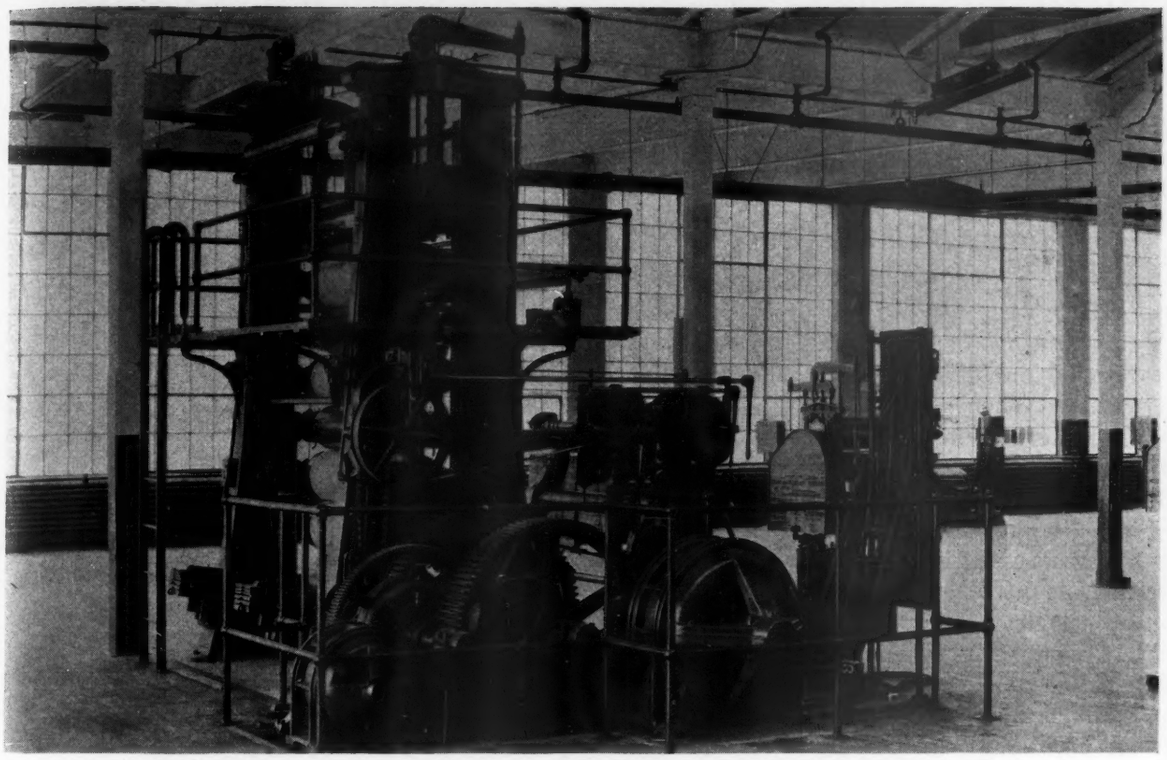
6. Provision must be made for emergency stops.

7. Reverse operation must be possible, in order to free the stack should a wad of paper become caught between the rolls.

To meet these requirements a two-motor drive has been developed, as shown in one of the accompanying



Wiring diagram of controls for a two-motor, super-calender drive.



A 50-in., nine-roll stack paper calender driven by a 75-hp. main motor and a 7½-hp. threading motor. The push-button stations are mounted on the left-hand column of the calendar.

illustrations. The larger motor is connected by means of a solid-flange coupling to a short piece of shafting on which is mounted a chain pinion between two outboard bearings. The threading motor, by which slow speed is obtained, is geared to the chain sprocket shaft through a ratchet and pawl clutch. A small switch is mounted on the slipring end of the large motor.

The control consists primarily of a panel, master switch, and push-button stations. Reference to the accompanying diagram will make clear the sequence of the various steps of its operation.

The diagram shows all "Safe-Run" switches open. All of these must be closed before the equipment is started. The opening of any one of these "Safe-Run" switches will shut the equipment down. These stations can be placed at convenient places around the calender to give maximum protection to the workman.

Assuming that all "Safe-Run" switches are closed, the paper in the calender may be inched along by pressing the "Jog" button momentarily, which closes contactor *LEA* and puts current on the threading motor, *A*. If the "Jog" button is held down long enough, contactor *A1A* will close, short-circuiting the starting resistor for the threading motor. The closing of this contactor is delayed by a small, definite-time relay on contactor *LEA*.

If any one of the "slow" buttons is pressed, the equipment will come up to threading speed.

If the "fast" button on the main control station is pressed, the main motor, *B*, will accelerate the equipment smoothly to the speed predetermined by the setting of the master controller. The master controller may be set at any one of the five running speeds desired for the particular grade and kind of paper in process. These five speeds will fall in equal steps between 50 per cent and 100 per cent speed of motor *B*, based on full-load torque being required at all speeds.

When the operator desires to slow down the equipment while a damaged spot in the paper is going through the calender, one of the "Jog" buttons is pressed, which causes all accelerating contactors for main motor *B* to open, lowering the speed to approximately 50 per cent of full speed. When the "Jog" button is released, main motor *B* will return to its predetermined operating speed.

If it is desired to stop the calender and allow it to coast to rest, the "Stop-Brake" button is pressed half way down. If the "Stop-Brake" button is pressed all the way down, as in the case of an emergency, all contactors open and contactor *P* closes, plugging motor *B* on the line with a resistor in its primary circuit in such a manner that it will exert torque in the opposite direction. This will cause the equipment to come to rest quickly.

As soon as the motor comes to rest and starts to turn in the opposite direction, contactor *P* will open, as its magnet coil is fed through a small switch placed on the slipring end of the shaft on the main motor.

If it is desired to reverse the calender rolls, a small "Reset" push-button station is pressed, short-circuiting the small switch on the shaft of the main motor, causing the plugging contactor, *P*, to close and reversing the equipment.

Thermal protective relays, which follow the same heating characteristics as the motors, are furnished to give protection against overloads. A line switch enables the operator to disconnect the motors and control equipment from the source of power.

An ammeter is placed in the line and should be so installed that the operator at the main control station can use it as an indication of the correct amount of pressure to put on the calender rolls to give the desired finish to the paper.

INDUSTRIAL ENGINEERING

Covering the Plant Engineering Function in Industry

L. C. MORROW, *Editor*

Chicago, August, 1929

Industry Will Do More Air Conditioning

WHEREVER quality of product demands, air is being conditioned. When cloth must be woven in humidified air, humidifiers are put into service. When paper must be printed in a dry atmosphere, dehumidifiers are set to work. When painting must be done in air free from dust, air cleaners are installed. And so it goes.

It is logical to develop first the product, second production, and third the producers. As the more difficult problems of the first two are solved industry will devote more attention to the third, and that from two points of view: the welfare of its workers; and the effect upon production. There will be much more man-cooling and man-heating, insulating, ventilating, air-conditioning.

The trend of thought in this direction is indicated by the action of colleges in developing more comprehensive courses in air conditioning and mechanical ventilation. Among the colleges so proceeding are Columbia, Harvard, Illinois, Kentucky, Massachusetts Institute of Technolgy, Michigan, Ohio State, Purdue, and Yale.

Carnegie Institute of Technology has opened a comprehensive course in "fans." The Mellon Institute is studying smoke and its control. Colgate University has completed a laboratory in which any kind of air conditions can be created.

This job of air-conditioning naturally belongs to the plant-engineering function. It is one of the details of the job that are continually broadening the scope of the function. When the function broadens the functionary must broaden with it, if he wants to keep the job. So a wise plant engineer will become somewhat of an "air" engineer and a ventilating engineer—by way of looking toward the future.

Are Prices of Leather Belting Going Down?

PRICES of leather belting are not likely to go down during the last half of 1929. Consideration of the following figures of record permits of no other conclusion:

Hides advanced from 15c per pound in March, 1927, to 26½ per pound in January, 1928. During 1929 the price averaged 25c, an advance over the low of March, 1927, of 65 per cent.

Belting butts advanced from 59c per pound in March, 1927, to 81c through the first eight months of 1928, an advance of about 37 per cent.

During the same period the advance in prices of leather belting averaged 12 per cent.

The present price of hides is 18c and of belting butts is 72c, representing 20 and 22 per cent increases over the prices of March, 1927.

Leather belting at present is priced 18 per cent over the prices of March, 1927.

Apparently the prices of hides are not yet low enough to justify reduction in the prices of belting. Moreover, any duty on hides and leather, coupled with this year's lower production rate, will react in the other direction.

Buyers, Sellers, and Service

PROGRESSIVE manufacturers and dealers have learned that they acquire substantial blocks of good-will when they furnish engineering service along with the equipment that they sell. Perhaps the sale of a belt may call for the recommendation by the seller of a certain type of pulley to insure maximum service. Or the conditions may be reversed. Clutches, couplings, or other units for power transmission, for example—even the entire drive—may be involved.

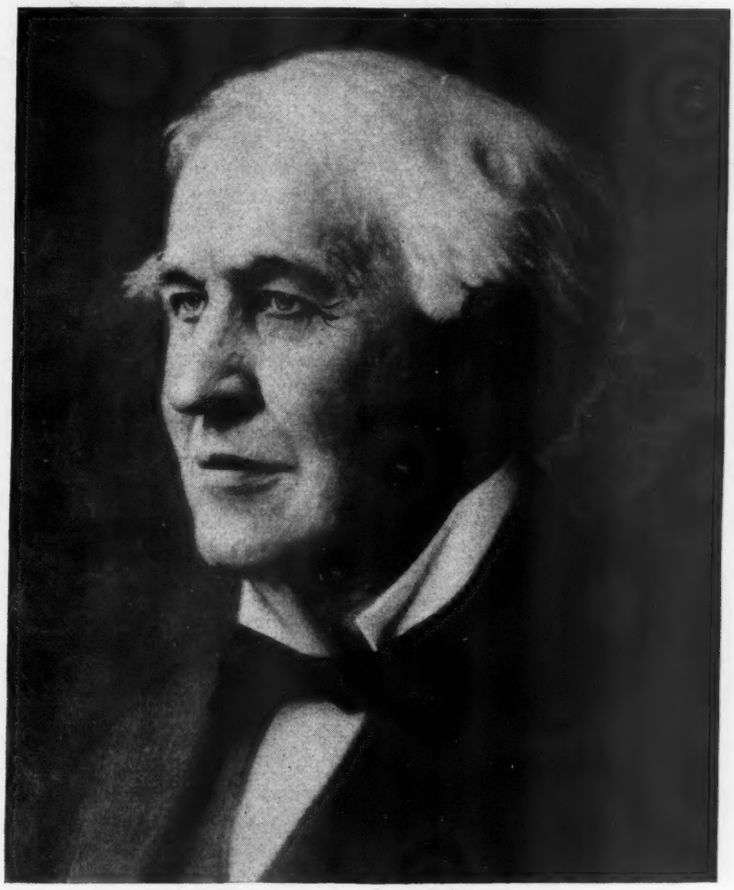
One of the difficulties encountered in following the policy of furnishing service with sales is the unwillingness of the buyer to receive it. His attitude may be one of resentment against the inference that he does not know as much as the seller about his own job. Or he may feel that in some way the seller is making additional profit from the extra sale, if one is made.

There is no good reason why the policy should not be acceptable, however, if persisted in. The business of selling, to be successful, must be accompanied by good-will, and the wise seller will not let items of immediate financial gain influence his service recommendations. There is, also, every reason why the seller who is really on the job should know more than his customer about the problems that are solved by the use of his equipment and the combinations with other units best suited to secure results. He is constantly studying his equipment in operation, sees it in all kinds of combinations and under all conditions. He will know that he cannot hope to make unsound recommendations for long.

More manufacturers and dealers are urged to give thorough study to the problems of their customers, with the idea of rendering engineering service. And plant men are advised to believe that they may have equipment problems of importance even though they don't recognize them as such, and to take advantage of the service now being made available by the really progressive manufacturers, dealers, and supply houses.

THE GOLDEN JUBILEE OF LIGHT

A Tribute to Thomas A. Edison



THE Golden Jubilee of Light is now in progress. Atlantic City presented the opening electrical display on May 31. Other cities and towns have followed. The jubilee is to culminate October 21, when Thomas A. Edison will repeat the original experiments which 50 years ago marked the birth of the successful electric lamp. These experiments will be reproduced in the reconstructed laboratory at Dearborn, Michigan, which has been built by Henry Ford. On the night of October 21 it is hoped that every light in the United States will be turned on, thus "relighting the world." Industrial plants ordinarily closed at night should, upon this occasion, show their lights with all the brilliance possible.

It is given to few men to look over the span of 50 years and see with mortal eyes the blessings that their genius has showered upon a grateful people—rarely is it possible for a grateful people to express to a living man their appreciation of his gifts and accord him those simple, friendly tributes which are beyond all bronze and beyond all marble.

Light's Golden Jubilee is that sort of tribute to Thomas Alva Edison. Though his life is filled to overflowing with contributions to the public good, he will always be best remembered as the Father of the Incandescent Lamp.

Light's Golden Jubilee is but an opportunity for this world at large to stand beside the man whose genius made possible a world forever free from darkness—a world of increasing productivity—a world of growing comfort, of expanding safety and improving health and consider with him what 50 years have wrought.

Mr. Edison is now 82 years old. His most important invention has made it possible for all of us literally to step forward out of darkness. His other inventions have rendered to us many services and have brought us much pleasure.

It is a privilege, therefore, to give en masse this sign of our appreciation of his services.

Power Transmission Through Friction Clutches

(Continued from page 406)

and bring it up to speed before applying the load. The driven pulley can be mounted on a quill, permitting it to revolve freely as long as desired and then, by the operation of the clutch attached to the quill, the load can be picked up gradually.

The inside diameter or bore of a quill should be about ¼ in. larger than the shaft diameter. If the quill is to transmit the full power of the shaft a safe rule for the outside diameter of a cast-iron quill is one and three-fourths times the shaft diameter. Fig. 23 shows a typical quill installation.

Factors Affecting the Selection and Operation of Friction Clutches

When selecting the proper size of clutch for an installation, it is necessary to consider carefully four main points as follows:

1. *Load Conditions*—The type of load to be handled is the first factor to be taken into consideration. This includes *(a)* the nature of the load; that is, whether it is steady, or subject to large or small fluctuations. *(b)* The horsepower to be transmitted. *(c)* The rate of pick-up. Normally, a clutch will require from 6 to 8 seconds to bring the load up to speed. A longer time will cause excessive wear. To shorten the time, use a larger clutch.

2. *Speed of Clutch*—The speed in revolutions per minute is the second important factor to be considered, because the horsepower transmitted does not increase in direct proportion to the speed increase, except in the case of a clutch used as a safety coupling and operated only at rare intervals. High speed is conducive to slippage, except when a clutch acts merely as a safety coupling.

3. *Power Used and Method of Application*—Complete data on the source of power used and method of application are necessary to select the proper size of clutch.

Steady torque is developed by electric motors. This is best source of power from a clutch standpoint.

Steam engines give an almost steady flow of power. The pulsations are close together and are delivered through a steady push or pull.

Two-cycle oil or gas engines give nearly a steady power-flow, as there is little or no lapsed time between power impulses. Multiple-cylinder motors give a more even flow than do the single—or twin-cylinder engines.

4. *Operation*—Conditions that affect the operation of a clutch are:

(a) Frequency of engagement. There may be a small number of engagements per day as for lineshafts and jackshafts. A large number of engagements are required for tractors, cranes, elevators, lathes, automatic machinery, trippers, etc. This service requires a larger clutch than is required for case *(a)*, to offset the wear caused by frequent operation.

(b) Methods of engagement, such as automatic with no cushioning device; automatic with cushioning device; hand engagement where quick action is not necessary; hand engagement where quick action is necessary and the operators are unskilled.

(c) The care that the clutch will likely receive. This feature depends largely on the location—whether accessible or not—and the class of operator.

(d) Atmospheric and general operating conditions; that is, operation in the presence of dampness, dust, oil, and so on.

(e) Use of shaft large enough to avoid deflection, number of bearings on shaft and location of the clutch with respect to the bearings.

(f) Mounting of clutch—whether on continuous shaft for use as cut-off coupling. This involves the question of the liability of radial or angular misalignment, of the shaft and the possibility of endwise movement.

(g) Method of taking power from the clutch; that is, through a gear or pulley on the sleeve, or through an extended shaft.

Substations Need Systematic Maintenance

(Continued from page 397)

After the foregoing work is done by the maintainer it is very important that the equipment be put through a complete cycle of operation before he leaves the substation.

The second class of maintenance work includes those things which must be taken care of at less frequent intervals. It is in the nature of a thorough overhauling and on the average should be done semi-annually.

At this time all protective relays should be checked for operation and calibration. Alternating-current relays such as overload, short-circuit, phase-balance, etc., can be tested with a regular current testing outfit, whereas direct-current devices such as overload and underload relays should be checked with a milli-voltmeter, however, the reverse-current relay can be checked most accurately by actually idling the machine from the d.c. bus. All timing relays should be checked with a stop watch. On most properties the Meter Department will check all meters semi-annually and it is suggested that this work be added to their routine and made their responsibility.

The overspeed device should be checked by operating the unit from the d.c. side with weakened shunt field, the speed to be read by using a tachometer.

All thermostats must be set by heating them to the specified or desired operating temperature. Bearing and feeder-copper thermostats operate at 90 to 100 deg. C. and can be heated to operating temperature in a pot of hot water. Grid thermostats operate at 300 deg. C. and, therefore, must be heated in a hot air stove.

Each terminal on the rear of the switchboard and on the interlocks of auxiliary apparatus must be tested to make sure that they are tight. It will be found that this can best be accomplished if a set of small socket wrenches is available.

An adequate stock of replacement parts will be of considerable help in solving one portion of the maintenance problem.

NEW EQUIPMENT

For Plant Operation and Maintenance

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these new devices which are designed to improve plant operation or reduce operating and maintenance costs.

Diamond Electrical Distribution and Engineering Service

A NATION-WIDE distribution and engineering service has been announced by the Diamond Electrical Manufacturing Company, Los Angeles, Calif., through arrangements with the Union Electrical Manufacturing Company, Milwaukee, Wis., for the distribution of Diamond E products east of the Mississippi River.

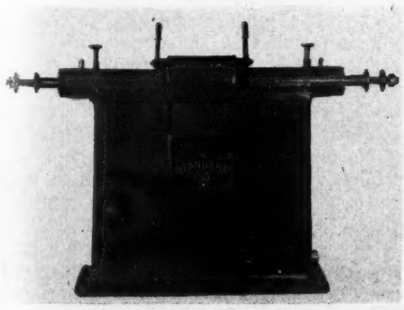
The Union Electrical Manufacturing Company maintains offices and stock in all of the principal cities of the East, at which depots Diamond E products may now be obtained.

Standard Buffer and Polisher

THE illustration shows the Standard Right Speed-Two Motor-Buffer and Polisher, which is manufactured by The Standard Electrical Tool Co., Cincinnati, Ohio. This machine is made in 3, 5, and 7½-hp. sizes. Any speed from 2,000 to 3,000 r.p.m. can be obtained by changing pulleys on the motor shaft.

This buffer has two motors in the base, and each motor is mounted on a hinged base plate which has an adjustable screw to take up the tension of the Dayton Cog Belts. These belts run in V grooved cast iron pulleys.

The spindles are made of a high grade nickel steel. The bearings are S.K.F. ball bearings mounted in dust-proof chambers. All bearings run in oil. Each spindle is fitted with a hand brake for stopping quickly, and also with shaft lock for locking shaft when changing wheels. Spindles can be furnished any length as desired.

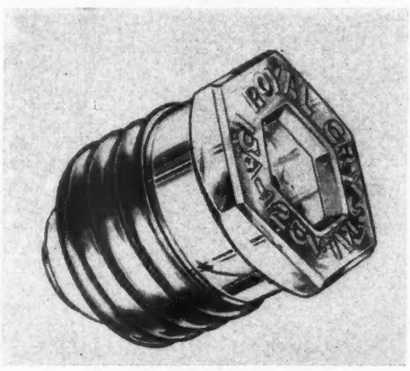


Standard Right-Speed-Two Motor Buffer and Polisher

The buffer is powered with G. E. 40 deg. ball bearing motors, and each motor has an independent push button control. The back of the machine is made of heavy sheet metal and hinged to the base so it can be raised easily, permitting a full view and access to the entire machine.

Royal Crystal Glass Top Fuses

ANNOUNCEMENT has been made of the development of Crystal glass top fuses with hexagon head which have been patented by the Royal Electric Company, Chelsea, Mass. The feature of the design emphasized in the announcement is the hexagon head which will characterize all Royal Crystal Fuses of 15 amp. or under.



Royal Crystal Glass Top Fuse

It is claimed, it simplifies the question of replacement for the trouble man; the shape of the fuse indicating even in the dark the condition of the circuit, whether it is over or under fused.

General Electric Time Delay Device

A TIME delay device announced by the General Electric Company, Schenectady, N. Y., is designed for use with manual operating levers of that company's types HA-2 and HC-2 for switchboard type oil circuit breakers. The new device can be used in place of a relay where a time delay, not necessarily exact or selective, is desired. It cannot be used with a breaker required to start on full voltage.

The complete device consists of a coil, a calibrating tube and a piston dash-pot. Current adjustment is made by setting the armature at the desired ampere value marked on the tube. Time delay is varied by changing the size of the opening in the piston valve.

The device can be obtained to replace instantaneous trip devices in operating levers of above types already installed.

Westinghouse Buys Elevator Signal Company

THE Westinghouse Electric Elevator Company, E. Pittsburgh, Pa., announces the purchase of the Norton-Blair-Douglass Company, N. Y., manufacturers of a complete line of elevator signals and electric and manual door operators.

This acquisition, it is stated, gives the Westinghouse Company a better control of all engineering features of elevator installations.

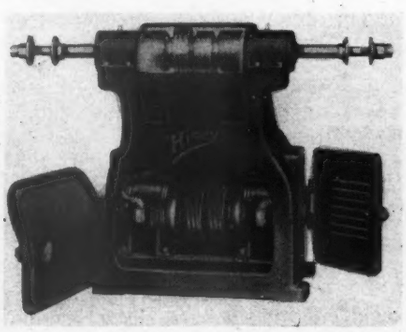
Hisey-Wolf TexDrive Buffer

A DUAL-MOTORED TexDrive buffer with two separate and distinct spindles, each operated by its own motor, has been announced by the Hisey-Wolf Machine Company, Cincinnati, Ohio. Either spindle may be operated independent of the other. Each motor has its own starter and can be stopped or started at will. This arrangement makes it possible to have the two spindles operating at different speeds at the same time.

This machine embodies a goose-neck design which gives the operator greater freedom of movement and permits easy handling of large and bulky pieces. The base consists of a substantial casting inside of which is mounted the motor, starter and starting switch. The spindle and bearing housing are assembled as a unit. This unit may be removed quickly from the base by loosening four bolts on each side.

The motor is mounted on a solid, cast-iron sub-base which is securely bolted to the main frame. The motor is secured to the sub-base on all four corners by bolts placed in grooves.

Automatic lubrication is obtained by a simplified oiling system. The Tex-Drive buffer is made in two styles, with single motor drive and with dual motor drive.



Hisey-Wolf TexDrive Buffer

Hill-Curtis Electric Polishing and Buffing Lathe

A MOTOR-IN-BASE, electric, polishing and buffing lathe is being marketed by the Hill-Curtis Company, Kalamazoo, Mich., under the trade name of "Rite Speed." This machine is furnished in the style as shown in the accompanying illustration, also with the overhanging type of spindle.

Power is transmitted from the motor which is mounted in the pedestal to the spindle by means of a Multi-V type belt, thereby making it possible to furnish this machine in any speed desired. Adjustment for taking up slack in belts is made from the outside of the machine without disturbing the motor mounting. Timken roller bearings or ball bearings are furnished as preferred. Automatic motor starter with overload protection is standard equipment.

Hill-Curtis Electric Polishing and Buffing Lathe

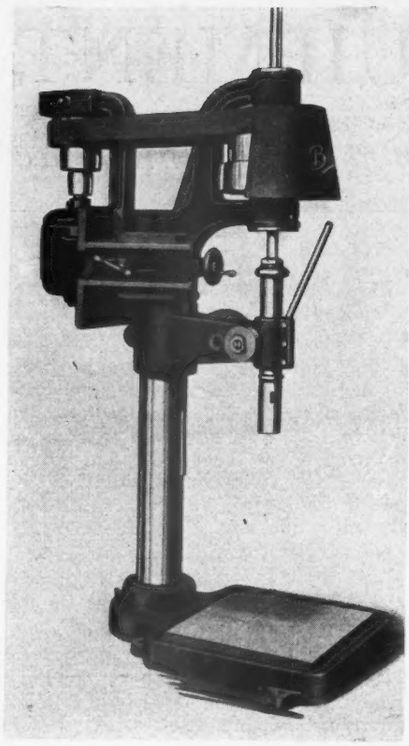
The combination switch and brake feature is incorporated on all Rite Speed polishing machines. With this design, it is only necessary that the operator pull the lever forward to break the current connection and apply the brake. The brake is released and the motor started by reversing this operation.

Buffalo Forge 16-in. Sensitive Drills

ANNOUNCEMENT has been made by the Buffalo Forge Company, Buffalo, N. Y., of the development of 16-in. Sensitive Drills.

These devices will drill 5/8- to 7/8-in. holes in cast iron; the head has a travel of 8½ in. while the spindle travel is unusually long, 7 in. They are equipped with SKF ball bearings and are available in floor and bench types.

Comparative specifications of these two types are available in Form 2677. The pulley and motor support is made of cast iron. The outer part of the spindle is guided by a sleeve running in bronze bearings provided with a ball thrust bearing. Three spindle speeds



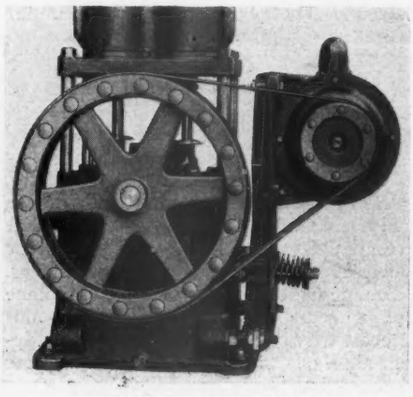
Buffalo Forge Bench Type 16-inch Sensitive Motor-Driven Drill

are provided; 418, 835, and 1725 r.p.m. A hand lever feed is provided on the bench type, and hand lever and foot treadle are provided for speed and convenience in the floor type. A knurled nut directly back of the feed pinion permits idling of the foot treadle at any time. The foot treadle attachment can be had if desired.

Rockwood Uni-Pull Drive

THE Rockwood Manufacturing Company, Indianapolis, Ind., is marketing a short-center drive unit, known as the Uni-Pull, which may be used on a single machine or a line-shaft group. It may be mounted on the floor, on the machine, on a platform, or suspended from the ceiling. The pulley centers need only be far enough apart that the pulleys do not touch.

As a unit, it consists of an electric motor, an ordinary flat belt and two standard paper pulleys. The motor is mounted on a free-moving pivot in order that its gravity weight may automatically maintain the belt tension necessary to insure a uniform flow of power at all times.

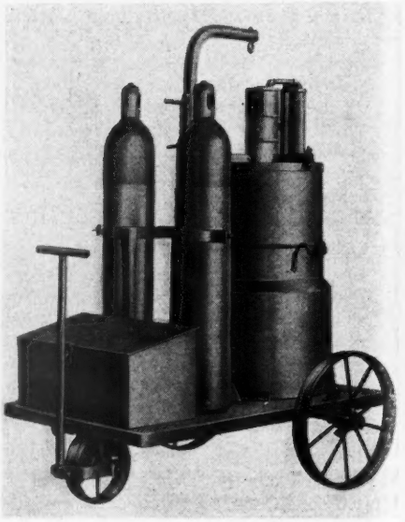


Rockwood Uni-Pull Drive

Oxweld Acetylene Trucks for Carbic Generators

THE Oxweld Acetylene Company, 30 E. 42nd St., New York, N. Y., introduces two types of trucks to accommodate Type CLP-3 and Type CLP-2 Carbic low-pressure acetylene generators, respectively.

The truck designed to carry a CLP-3 Carbic generator also carries two cylinders of oxygen. Two large wheels carry the back part of the truck; a third wheel, in the front, is of the castor type and allows the truck to be turned in a radius about equal to its own length.



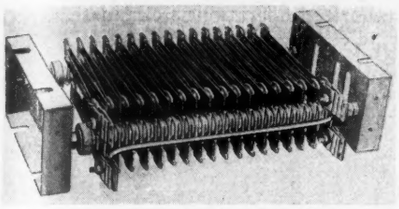
Oxweld Acetylene Truck for Type CLP-3 Carbic Generator

The truck is provided with a steel tool box with loop fastenings. This box can be used for wrenches, small tools, or for a welding or cutting outfit. The oxygen cylinders are chained to a steel rack which is fastened to the deck of the truck beside the generator. A crane is provided to be used in charging and emptying the generator. The crane jib is made in three sections which can be telescoped when not in use to decrease the height. The truck has two 24-in. steel wheels with 3-in. tires, and a castor wheel which is 12 in. in diameter by 2 in. All wheels are provided with grease cups for lubrication.

The smaller truck will accommodate one cylinder of oxygen in addition to the Type CLP-2 Carbic generator. There are two 24-in. steel wheels and one 5-in. castor wheel operating on a roller bearing.

Cutler-Hammer "DUR-ristor" Unbreakable Resistor

AN unbreakable resistor with a continuous resistance element, designated as the "DUR-ristor," is announced by Cutler-Hammer, Inc., Milwaukee, Wis. According to the



Cutler-Hammer DUR-ristor Unbreakable Resistor

announcement, it was designed to meet the needs for a resistor which would give maximum service under the most severe operating conditions.

The resistance element consists of two continuous unbreakable strips which are made of a rust-proof, noncorrodible alloy. The method of supporting the strips, combined with the ribbing, permits the strips to expand and contract freely during temperature changes. All brittle material has been eliminated and mica is used for all insulation.

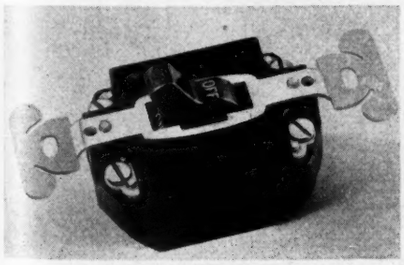
All DUR-ristors, regardless of ampere rating, are of equal size. The thickness of the resistance strip is the only part that varies in size; that is, according to ampere rating.

Hubbell Shallow Flush Toggle Switch

ANNOUNCEMENT has been made by Harvey Hubbell, Inc., Bridgeport, Conn., of the development of a shallow flush toggle switch having a form of contact spring which prevents burning of the contacts at "make."

This form of contact spring is designed so that two different rates of vibration are set up in the spring; one tending to counteract the other, it is stated. Thus recoil is practically eliminated in the ends of the contact spring when the solid metal contact blade strikes between them. As a result, burning and pitting of the spring is prevented, even when in circuit with type "C" lamps.

An automatic kick off prevents sticking of the blades in contact. The commutator blades are rigidly riveted to the carrier, insuring positive alignment. The spring arm is pivoted on a round shaft which is seated in a symmetrical bearing. The operating mechanism is separate and insulated from the bridge. Each wiring terminal is held by two screws. A Bakelite case completely incloses the mechanism.

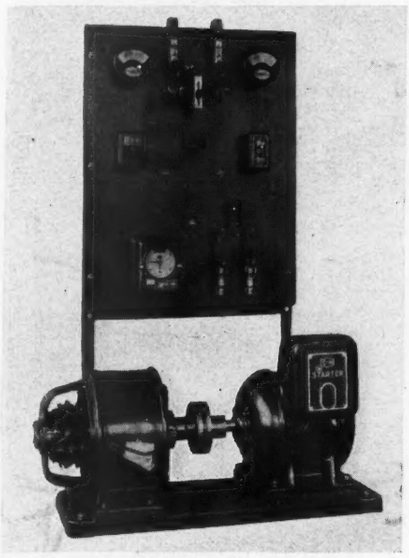


Hubbell Shallow Flush Toggle Switch

Engberg Battery Chargers

ANNOUNCEMENT has been made by the Engberg's Electric and Mechanical Works, St. Joseph, Mich., of the marketing of battery chargers for manually or automatically charging one or more lead or Edison batteries.

These battery chargers consist of a four-bearing motor generator; both motor and generator having two antifriction bearings and being direct connected by an insulated flexible coupling.



Engberg's Manual or Automatic Battery Charger

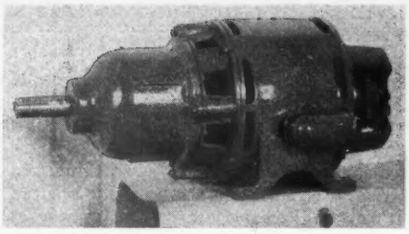
The motor and generator are mounted on a self-supporting cast-iron base plate.

The generator is furnished to suit the speed requirements of each battery installation. The motor can be furnished either in a.c. or d.c. styles. The switchboard is equipped for manual or automatic charging of single or multiple batteries.

Crocker-Wheeler Speed Changers

ANNOUNCEMENT has been made by the Crocker-Wheeler Electric Manufacturing Company, Ampere, N. J., of the introduction to the American market under the *Garrard patents* of Speed Changers designated as Type C and Type S Gears.

Among the outstanding advantages claimed for these gears are quiet and vibrationless operation, high efficiency, suitability for high speeds, compactness, completely inclosed and, therefore, dirtproof.



Crocker-Wheeler Type C Speed Changer built into rear shield of 15-h.p. motor

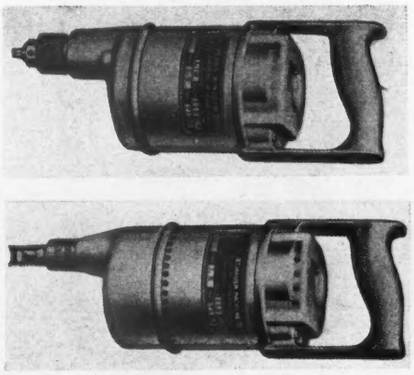
The type of gear introduced is a complete departure from previous practice in that power is transmitted by adhesion. The torque or turning effort is transmitted by hardened steel cylindrical surfaces accurately ground to size and pressed together, not by the shaft bearings, but by means which automatically increase the pressure as the load increases. For lubrication and cooling purposes, the internal parts of the gears are run in a bath of oil.

As a reducer the C-type gear is designed for ratios between 1¼ to 1 and 10 to 1. As an increasor, for ratios between 1 and 1¼ and 1 to 4. The standard gear may be inverted for ceiling mounting.

The S-type gear is a development of the planetary gear system, but hardened steel rollers and rings are used instead of the sun and planet tooth gears. The S-type gear is normally manufactured as a reducer with ratios between 3 to 1 and 10 to 1 and as the speed increases with the same limits of ratios. In the case of the S-type gearmotor combination the standard bearing bracket is replaced by a special adaptor which forms the end bracket of the motor and also supports the gear. The C-type gears are coupled to the motor and both are mounted on a bed plate.

Schauer Portable Electric Tools

THE Schauer Machine Company, successor to The Neil & Smith Electric Tool Company, Cincinnati, Ohio, is featuring two tools recently



Schauer Portable Electric Screwdriver (below) and ¼-In. Drill

developed, a quarter-inch drill and a screwdriver, as illustrated.

Both tools employ the same type of motor. The cover cap is removable without disturbing bearings or electrical connections and permits inspection of the motor while running. They are ball-bearing equipped, with inclosed ball thrust bearings and heat-treated nickel steel gears running in grease.

The screwdriver is equipped with a screw-slot finder and finder bit, but it can be operated without the finder if necessary, or with the socket bit for nut tightening. One of the principal features is that no moving parts are exposed to mar the work in case of slipping or close corner operation. The positive clutch and thrust bearings are located in the gear head. This feature provides positive lubrication and allows the use of a large diameter clutch with the tool.

Yale & Towne Acquires Stuebing-Cowan

ANNOUNCEMENT has been made by the Yale & Towne Manufacturing Company, Stamford, Conn., of the purchase of The Stuebing-Cowan Company, Cincinnati, Ohio, and Holyoke, Mass., makers of hand lift trucks.

The announcement further states that the purchase of the Stuebing-Cowan interests will add a complete line of single and multiple lift hand trucks to the Yale & Towne line of devices for the handling of materials.

G. E. Manual Starting Switch

A MANUAL starting switch announced by the General Electric Company, Schenectady, N. Y., is designed particularly to meet the demand for a small device which will throw motors across the line. The switch bears the designation CR-1038-E-1 and has a maximum rating of 1 hp. at 110 volts, and 2 hp. at from 220 to 600 volts, three phase.

G. E. Manual Starting Switch

The device consists of a tumbler switch and two small thermal cutouts mounted on a common textolite base. By means of suitable interlocks the switch can be locked in either the open or closed position.

The cut-out links are made of tinned copper to prevent oxidation, and the contact spring and post are also tin plated for the same reason.

Westinghouse Reversing Drum Controller

A LINE of reversing drum controllers is announced by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. These controllers to be known as Type A

Westinghouse Reversing Drum Controller

controllers, are listed in classes 8300 and 8400 for d.c. service, and in classes 12-700 and 12-800 for a.c. service. They are designed for heavy usage in operating cranes, hoists, bending rolls, railway turntables and the like.

The drum cylinder consists of rolled brass supporting discs assembled on a micarta insulated steel shaft between brass and micarta insulating collars. The contact segments are bolted to the supporting discs in such a way as to entirely eliminate burning of the bolt heads. The segments are reversible, which doubles their operating life.

The fingers are of the compensating, self-aligning type which assure square alignment on the contact segments. An adjustment is provided to compensate for finger wear while localized heating of the joints is prevented by copper shunts direct from the terminals to the finger tips.

In construction castings have been replaced by steel parts wherever practicable to provide maximum strength with reduced size. The wiring of this controller is unusually simple because of its removable back cover, its ample wiring space behind the rotating contacts, and its large opening in the base. For safety a simple latch is located in the handle to prevent its unintentional moving by an accidental knock, and unauthorized operation is eliminated by a handle lock.

Chicago Steel & Wire Takes Over Fusion Welding

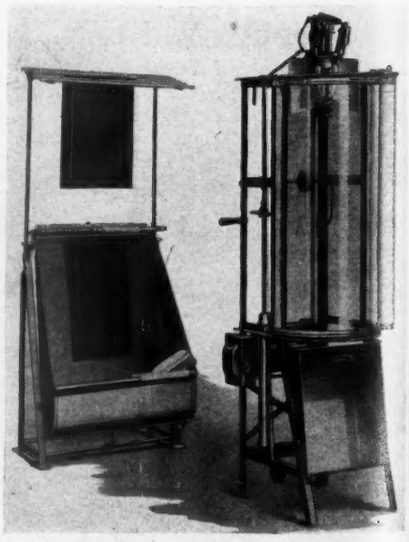
ANNOUNCEMENT has been made to the effect that the Fusion Welding Corporation, 103rd St. and Torrence Ave., Chicago, Ill., a subsidiary of the Chicago Steel & Wire Company, has taken over the sale of all welding rod manufactured by the parent company. The change provides one source of supply for both Weldite welding rods and Fuzon welding equipment and accessories previously sold by the two companies.

The Fusion Welding Corporation is owned outright by the Chicago Steel & Wire Company.

Pease Junior Blue Printing Machine and Sheet Washer

THE C. F. Pease Company, 813 N. Franklin St., Chicago, Ill., announces the Junior Blue Printing Machine and Sheet Washer for use in drafting rooms where only a small quantity of blue prints is required or where emergency prints are wanted in a hurry.

A floor space of 22x26 in. is required for the blue printing machine and 24x34 in. will accommodate the sheet washer. Blue prints of any size up to 24x36 in. can be turned out in from 1 to 1½ min. with one drop of the lamp. The current consumption of the Type P arc lamp with which the



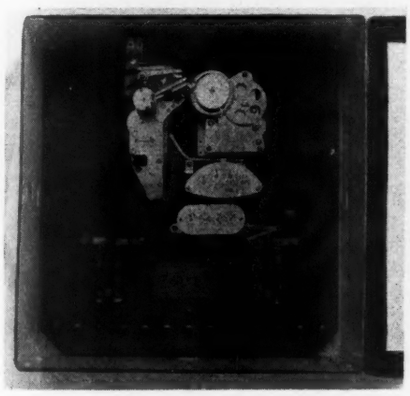
Pease Junior Blue Printing Machine and Sheet Washer

machine is equipped is 7½ amp. on 220 volt d.c. or a.c. and 10 amp. on 110 volts. The drop of the lamp is controlled by a patented cylindrical oil control which provides a regulation for any required printing speed. The Sheet Washer as shown in the illustration was especially designed for use with the Junior Blue Printing Machine. After bichromate of potash is applied from the tray at the bottom with the brush, a spray of clear water is turned on to wash off the surplus potash. Both machines are furnished in olive green enamel.

Steelcity Furnace Power Demand "Limuter"

THE Steelcity Furnace Company, Pittsburgh, Pa., has developed and is marketing a device known as the "Limuter" for automatically reducing demand peaks. It works on an integrated peak basis and reduces the demand by cutting off temporarily, for short periods of time, some portion of the plant load which can be dropped without serious inconvenience. This load reduction occurs only during the latter part of the high-peak periods.

By using the Limuter, it is stated,



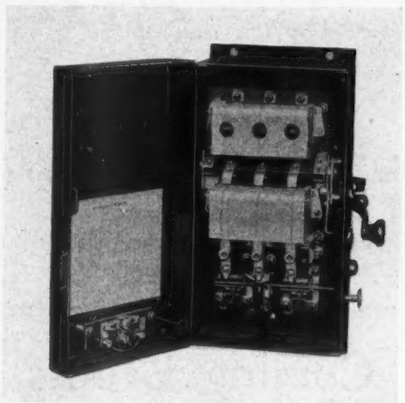
Steelcity Furnace Power Demand Limuter

the demand can be held to some predetermined value thus eliminating the unnecessary high peaks. The synchronous motor-driven clock of the Limuter is made so that the period of the Limuter is the same as that of the power company's demand meter such as 5, 15, 30 or 60 min. and being in synchronism it allows full power to be used up to the time that the predetermined setting of the demand is about to be exceeded, and then reduces the load to the desired point.

It is the function of the Limuter to cut the load when the predetermined amount of power has been used, and then, when the demand peak interval is over, to throw back automatically the apparatus into its normal operating condition. If the load cannot be automatically restored, a signal is used to indicate that the danger period is over and the load is thrown back on the line by hand.

Square D Combination Automatic Starter

A COMBINATION starter for automatic electric motor control and which is made in three capacities and in six types has been placed on the market by the Square D Company, In-



Square D Class 8532-S, type A, 20-amp. Combination Starter

dustrial Controller Division, Milwaukee, Wis. Each combination starter is a complete unit consisting of an across-the-line starter combined with a motor circuit switch mounted together in one cabinet. The motor switch not only acts as a disconnecting switch but also is capable of opening the circuit while the motor is under load.

To facilitate the obtaining of accurate load data on motors while they are operating under working conditions, the combination starters are arranged for the insertion of a test jack in the motor circuit switch while the motor is running. The test jack is inserted through openings in the door of the starter and passes between the jaws of the switch where it is firmly held by the spring tension of the switch contacts.

Lincoln "Kathode" Welding Electrode

A WELDING electrode, designated as the "Kathode" is being manufactured by the Lincoln Electric Company, Coit Rd. and Kirby Ave., Cleveland, Ohio, for the arc welding of mild steel and for cast iron repair work.

Because of the composition, as well as the special treatment given in its manufacture according to the announcement, this electrode flows easily with freedom from sputtering, and produces clean welds with minimum slag and oxidation. Also, the high heat permissible for use with this fast running electrode makes possible increased welding speed.

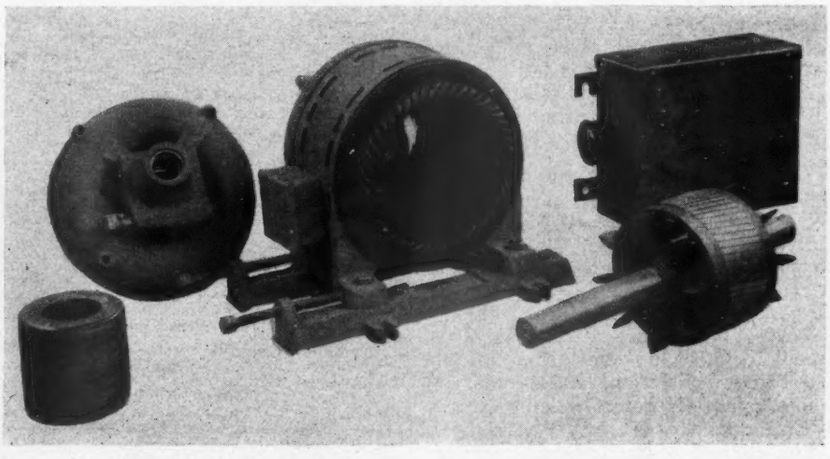
These electrodes are manufactured in stock lengths of 14 and 24 in. To provide best possible protection during shipment, the rod is packed in metal containers, each container holding 50 pounds.

Howell Red Band Brush-less Single-phase Motor

SIMPLICITY of design and construction is featured in an announcement by the Howell Electric Motors Company, Howell, Mich., in introducing the Red Band brush-less single-phase motor. The illustration shows its similarity in construction to the ordinary polyphase motor.

The only auxiliary equipment used in the operation of the single-phase motor is the starting unit shown behind the rotor, which contains starting condensers and the simple automatic contactor which disconnects the condensers from the circuit as the motor comes up to full speed. Because of this feature of its design the motor has no brushes, commutators, internal switching devices or wire-wound rotor. Since it has no sliding contacts it will not spark.

The motor can be reversed at full speed without injury, making it a practical motor for the single-phase operation of machine tools, elevators, hoists, automatic doors and windows, etc., as well as for the application as a general purpose motor.



Howell Red Band Brush-less Single-phase Motor Dis-assembled

TRADE LITERATURE

You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog desired, as given in these columns.

(164) TRANSFORMERS—Bulletin No. 27 contains 80 pages devoted to Kuhlman transformers; the method of manufacture, their construction, and some typical installations.—Kuhlman Electric Company, Bay City, Mich.

(165) STEEL SHELVING—A complete line of steel shelving, lockers, bins and closets for industrial and commercial use is described and illustrated in Folder No. 289.—Richard W. Jefferis Company, Camden, N. J.

(166) RIVET PIERCING TIP—Bulletin 271 introduces the Milburn rivet piercing tip. The tip operates by centering over the rivet head and burning a core out of the body. The rivet is then backed out.—The Alexander Milburn Company, Baltimore, Md.

(167) OIL PURIFIERS—Leaflet No. 20240C on the Sharples Super Centrifuge Oil Purifiers now obtainable.—Westinghouse Electric and Manufacing Company, E. Pittsburgh, Pa.

(168) SINGLE-PHASE SYSTEM—Reprints of an article on "History of the Development of the Single-Phase System" for electric railway operation have been published by this company. Copies will be sent to those interested. —Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

(169) SELSYNS—A recently issued bulletin contains a complete description of the Selsyn system of remote control signaling and indication. — General Electric Company, Schenectady, N. Y.

(170) CONTROLLERS — Leaflet 20416 pertaining to Type A, d.c. drum controllers for general reversing service and for dynamic lowering hoist service has been released by Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.

(171) COG BELT DRIVE — Leaflet 20392, "Cog Belt Drives for Industrial Service," may be obtained upon request. —Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.

(172) ELECTRIC WELDING — Leaflet 20340-B on the general assembly, ratings, details and dimensions of the portable and stationary 300- and 400-amp. single-operator welding sets is being distributed by Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.

(173) CONTROLLERS—Bulletin 970 describes the types U, G, and V Dinkey ventilated controllers for a.c. slip ring motors.—The Electric Controller and Manufacturing Company, Cleveland, Ohio.

Coming Events

American Institute of Electrical Engineers—Annual Pacific Coast Convention. Sept. 3 to 6. F. L. Hutchinson, National Secretary, 33 W. 39th St., New York, N. Y.

National Association of Power Engineers—47th Annual Convention, Chattanooga, Tenn., Sept. 9 to 13, inc. The Power and Mechanical Exhibition will be conducted in conjunction with the convention. Ivon F. Pieters, president, Plibrico Jointless Firebrick Company, 1800 Kingsbury St., Chicago, Ill. S. M. Chapman, secretary, 5909 Kennerly Ave., St. Louis, Mo.

Chattanooga Power and Mechanical Exposition, in conjunction with 47th Convention of the National Association of Power Engineers. Chattanooga, Tenn., Sept. 9-13, inc. Frank N. Chapman, care of A. Leschen & Sons Rope Co., 5909 Kennerly Ave., St. Louis, Mo., secretary of the National Exhibitors' Association.

National Metal Congress—Cleveland, Ohio, September 9 to 13. Simultaneous meetings of the American Welding Society, Institute of Metals Division, American Institute of Mining and Metallurgical Engineers, Iron and Steel Division of American Society of Mechanical Engineers, Iron and Steel Division A.I.M.E., and the American Society for Steel Treating. W. H. Eisenman, secretary, 7016 Euclid Ave., Cleveland, Ohio.

Illuminating Engineering Society—23rd Annual Convention, September 24 to 27 incl., Bellevue-Stratford Hotel, Philadelphia, Pa., Illuminating Engineering Society, 29 West 39th St., New York City.

The National Electrical Manufacturers Association—The annual meeting will be held at the Wardman Park Hotel, Washington, D. C., the week of Oct. 7. Albert Pfaltz, National Electrical Manufacturers Association, 420 Lexington Ave., New York, N. Y.

National Electric Exposition—Oct. 7 to 12 incl., Grand Central Palace, New York, N. Y. Managers, Fred W. Payne and Charles F. Roth, 480 Lexington Ave., New York, N. Y.

American Gear Manufacturers Association—The semi-annual meeting will be held Oct. 24, 25, and 26, Benjamin Franklin Hotel, Philadelphia, Pa. Secretary's office, 3608 Euclid Ave., Cleveland, Ohio.

American Society of Heating and Ventilating Engineers—35 annual meeting, Jan. 27 to 30, 1930; Hotel Benjamin Franklin, Philadelphia, Pa.

National Factory Show—The first National Factory and Industrial Production Exposition will be held in Chicago in the early part of 1930. G. E. Pfisterer, president, The National Factory and Industrial Exposition, 308 West Washington St., Chicago, Ill.

(174) PUMPS—Catalog S and Hand Book lists part of the Gould line of standard stock types for road and building contracts, industrial plants, office buildings, mines, dairies and other services of like nature.—Goulds Pumps, Incorporated, Seneca Falls, New York.

(175) VENTILATING UNITS—Catalog 424, 32 pages on the description, design, and construction of Silex Conoidal ventilating units.—Buffalo Forge Company, Buffalo, N. Y.

(176) "PREVENTING FOUNDRY ACCIDENTS"—A discussion of the problem and methods followed by various foundries to develop safe working habits, published in report form by the Policy Holders Service Bureau of the Metropolitan Life Insurance Company. A copy may be obtained free of charge upon application.—Metropolitan Life Insurance Company, New York, N. Y.

(177) BEARING BRONZES—Research paper No. 68, "Bearing Bronzes, With and Without Zinc," by H. J. French, senior metallurgist, and E. M. Staples, research associate, Bureau of Standards.—Department of Commerce, Bureau of Standards, Washington.

(178) LAMP SHOCK ABSORBER—A new leaflet contains some important changes made in the construction of the Thompson Lamp Shock Absorber.—The Thompson Electric Company, 1428 West Ninth St., Cleveland, Ohio.

(179) "OXWELDING ALUMINUM AND ITS ALLOYS"—This booklet describes in detail oxwelding processes as applied to aluminum in all its forms. It includes complete instructions for oxwelding both cast and sheet aluminum and the strong alloys which lately have become so important in manufacturing processes.—The Linde Air Products Company, New York, N. Y.

(180) UNIT HEATER—The Humphrey Industrial Unit Heater, No. 100, a self-contained unit burning gas, is the subject of a recent bulletin.—General Gas Light Company, Kalamazoo, Mich.

(181) PIPE FITTINGS — Circular 1676-B, "Fittings for Pipe Structures," a complete revision of the old leaflet, including many new applications for these fittings.—Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

(182) NICKEL CAST IRON—Folder No. 201-A, "An Introduction to Nickel Cast Iron," first of a series of technical articles on this subject.—The International Nickel Company, 67 Wall St., New York City.

(183) RESUSCITATION — "Resuscitation in Gas Poisoning, Electric Shock and Drowning," Publication No. 289-70, issued jointly by the American Gas Association and the National Electric Light Association.

INDUSTRIAL ENGINEERING'S DATA SHEETS

Notes on Design of Stairs, Ladders, Ramps and Handrails

LAWS have been passed in various states laying down rules for the construction of stairways, ladders, ramps, and handrails, yet rule-of-thumb methods are in evidence. The accompanying notes on design are submitted for the guidance of those responsible for the details of construction of these devices.

1. The heights given for rails on both platforms and stair-runs are about 1 in. higher than the most convenient height for the average person, but for safety reasons have been so adopted.

2. The rail on the going down side of a stair-run should be about 3 in. higher than the rail on the going up side, but ordinarily the rails should be made the same height on both sides for practical reasons and the preferred height given has been established having this point in view.

3. Rails next to walls may safely be set lower than outside rails.

4. Rails on high platforms in dangerous situations should be set to the maximum height of 40 in. except in special cases.

5. As a general rule handrails should be placed on both sides of all stairways.

6. Note that railing post at top of stair-run must be set back a considerable distance from the edge of landing to avoid reverse bend in rail.

7. Within the shaded area given on the chart of stairs in constant use, risers may be varied from 6 to 7¾ in. and treads from 9¾ to 11¾ in. Good, safe stairways cannot be made outside of these limits for use by people of average American size.

For stairways used principally by grown-up persons, the sum of the riser and tread should be between 17½ to 18½ inches.

For stairways used principally by children, the sum of the riser and tread should be about 16½ inches.

Steps 7x11 in. will be found extremely easy and safe for general purposes.

8. As far as possible all stairways in a given building should have exactly the same riser and tread.

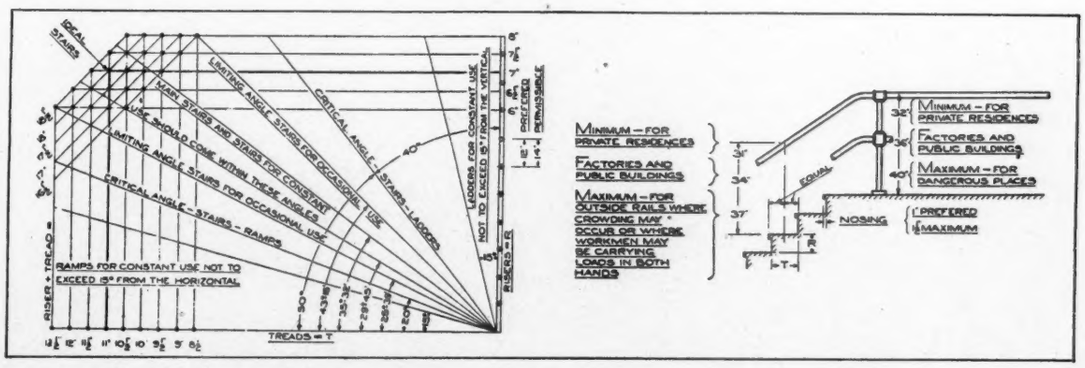
9. All stairways having long runs, of say, more than 15 steps, should be broken up by landings. Spiral turns on stairways should not be employed except in very special cases but are to be preferred to excessively steep runs in combination with flat landings. When spiral turns must be used, the center from which the treads are struck should be well inside the turn so the treads will not come to a point. This will involve tapering one or two treads on the straight run. The building ordinances of many cities prohibit the use of "winders" in factories, office buildings and in stairways serving more than three apartments, and in no case are more than three treads permitted in a quarter circle.

10. Stairways are extremely dangerous unless the bottom and top steps are well lighted. If these parts of a stair-run do not receive daylight, they should be artificially lighted and if likely to be used much at night, permanent 24-hr. lights should be provided which cannot be turned off except by the electrician in charge. Wherever possible steps and landings should have a distinctly different color.

11. Safe headroom for a tall person wearing a hat requires a minimum of 6 ft. 10 in. measured vertically from any tread.

13. Short ladders in daily use and all long ladders should be fitted with safety cage with continuous and smooth back.

By JEROME R. GEORGE, *Vice-President, The Morgan Construction Company, Worcester, Mass. Published in The Shop Review.*


IDEAL STAIRS
LIMITING ANGLE STAIRS FOR OCCASIONAL USE
STAIRS FOR CONSTANT USE
USE SHOULD COME WITHIN THESE ANGLES
LIMITING ANGLE STAIRS FOR CONSTANT USE
CRITICAL ANGLE - STAIRS - RAMPS
RAMPS FOR CONSTANT USE NOT TO EXCEED 15° FROM THE HORIZONTAL
RISER + TREAD =
TREADS = T
CRITICAL ANGLE - STAIRS - LADDERS
LADDERS FOR CONSTANT USE NOT TO EXCEED 8° FROM THE VERTICAL
PREFERRED
MAXIMUM
RISERS = R
MINIMUM - FOR PRIVATE RESIDENCES
FACTORIES AND PUBLIC BUILDINGS
MAXIMUM - FOR OUTSIDE RAILS WHERE CROWDING MAY OCCUR OR WHERE WORKMEN MAY BE CARRYING LOADS IN BOTH HANDS
EQUAL
NOSING
MINIMUM - FOR PRIVATE RESIDENCES
FACTORIES AND PUBLIC BUILDINGS
MAXIMUM - FOR DANGEROUS PLACES
PREFERRED
MAXIMUM

Metal Partitions for Toilets and Showers

Simplified Practice Recommendation

As the result of unanimous action on January 16, 1929, of a general conference of representative manufacturers, architects and engineers interested in metal partitions for toilets and showers, the Department of Commerce, through the Bureau of Standards, recommends to the industry that the accompanying simplified list of sizes and dimensions be established as shown.

These data are submitted for the guidance of plant engineers who are contemplating building changes and additions for the convenience of employees. This recommendation became effective July 1, 1929, subject to annual revision. Comments and suggestions are requested to make the recommendation more beneficial.

TOILET AND DRESSING ROOM DIMENSIONS

30, 32, 34, and 36 inches, center to center

(All dimensions in inches)

Partitions		Fronts		Doors	
Depth	Height	Width	Height	Width	Height
36	54	6	54	24	54
42	54	8	54	26	54
48	54	10	54	28	54
54	54	12	54	30	54
60	54	6	60	32	54
48	60	8	60	34	54
54	60	10	60	24	60
		12	60	26	60
				28	60
				30	60
				32	60
				34	60

All posts shall be 78 in. high (providing for head rail 12 in. above tops of 54-in. partitions and 6 in. above tops of 60-in. partitions).

Hardware—Self-closing hinges, latch, pull and bumper, and coat hook.

HEIGHT OFF FLOOR

Partitions and doors—The standard clearance between the floor and bottom of partitions and doors shall be 12 inches.

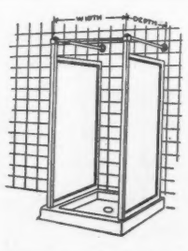
Backs—These shall be terminated on curbs at least 4 in. above floor level.

SHOWER INCLOSURES

30, 36 and 42 inches, center to center

Stock Sizes

Partitions		Fronts	
Depth	Height	Width	Height
36	66	12	66
42	66	18	66
36	72	12	72
42	72	18	72

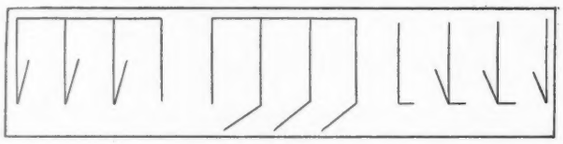


All posts shall be 78 in. high (providing for head rail 12 in. above tops of 66-in. partitions and 6 in. above tops of 72-in. partitions.

TYPICAL INCLOSURES

Dimensions recommended for all except special conditions.

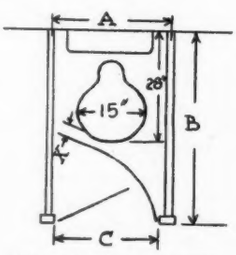
Arrangement	Size of Inclosures	
	Width c to c	Depth
Without doors	32	42
With full-width doors swinging out	32	48
With angle fronts and narrow doors swinging in	32	54
With full-width doors swinging in	32	60



Door Clearances—The following table and the sketch are to be used in determining the conditions under which an in-swinging door will clear the fixture, and the amount of such clearance.

A	B	C	X
30	54	28	1⅝
32	54	30	1 1/16
32	60	30	5⅝
36	60	34	2⅜

A—Width of Compartment.
B—Depth of Compartment.
C—Door opening.
X—Clearance.



Note—It is an exceptional fixture that projects 28 in. from wall to outside of seat.

GAGES OF STEEL

(Partitions for toilets, showers and dressing rooms)

Flush-type constructions—Partitions and doors panel-sheet steel shall be of No. 22 gage U. S. Standard (0.0313) or heavier.

Panel-type Constructions—In partitions of the following sizes or larger panel steel shall be No. 16 gage U. S. Standard (0.0625).

Depth	Height	Depth	Height
54	54	54	60
60	54	60	60

In partitions smaller than the aforementioned panel-sheet steel shall be of No. 18 gage U. S. Standard (0.05).

Doors—Panel-sheet steel, No. 18 U. S. Standard (0.05).

Finish—all material shall be finished in a prime coat, further finish to be considered an extra.